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8 EASY PROJECTS for ½A ENGINES

BY KEN WILLARD

BIG FUN WITH LITTLE ENGINES

You'll need only one power plant – an inexpensive two-cycle, internal-combustion .049 engine – for any or all of these projects, each of which offers hours of fun as it flies, skitters, floats, or spins about.

Novices and experienced modelers alike will enjoy building and operating the projects; friends and spectators will be amazed and amused by them.

About the author

Ken Willard has been involved with model and full-size aviation since the 1920s, when he set a world's record for indoor seaplane models and served as an assistant for barnstormer Eyer Sloniger.

Ken was later a meteorologist for American Airlines and the U. S. Army, an instructor for Parks Air College, a lightplane salesman, and a manager for Lockheed. He has designed hundreds of model airplanes over the years and was voted into the Academy of Model Aeronautics' Hall of Fame in 1977. Ken is now Associate Editor for *R/C Modeler* magazine, where he is often called the "Chief Sunday Flier."

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½ A Engines, Modeling Supplies, and Safety

This book provides eight simple, easy-to-build projects for beginning and intermediate modelers. All of the projects are easy to build; each flies, floats, rotates, or scuttles about; and each uses an .049 glow-ignition engine as its power plant.

Model airplane engines. Before going any further, let's briefly examine the history of small engines for model airplanes. The first models were powered by twisted rubber band motors. Then at one of the national model airplane meets in the early 1930s, a young man named Maxwell Bassett showed up with a model powered by a small spark-ignition gasoline engine that revolutionized the hobby. From then on, although rubber-powered models have continued to be designed and flown, gas-powered models have been most popular.

Early gas engines required a spark plug, a spark coil, a condenser (capacitor), and on-board batteries. The fuel was a mixture of white gasoline and SAE 70 oil. The engines were bulky and not particularly reliable.

As time passed, it became evident that the engines should be placed in classes based on cylinder displacement, which roughly correlated with power output. Three classes evolved; the smallest was Class A. It was limited to engines whose cylinder volume ranged from .09 cubic inch up to .19 cubic inch. Class B was for engines from .19 cubic inch to .29 cubic inch. Class C was for engines of .29 cubic inch and larger.

Also, some modelers discovered that when their engines became hot, they would continue to run even though the ignition was shut off. This led to the development of compression-ignition engines burning fuel containing ether, which has a very low flash point.

The first glow-ignition engines soon appeared. In 1949, K&B Manufacturing Co. designed an ultra-small glow-ignition engine, the Infant. Its cylinder size was .02 cubic inch, far below the .09 displacement of the smallest Class A engines.

Instead of a spark plug, the engine used a glow plug containing a small coil of platinum wire. A 1.5-volt dry cell heated this wire orange-hot while the engine was being started; the heat of combustion then kept the wire glowing as long as the engine ran. The Infant and other glow-ignition engines that followed did away with spark plugs, coils, condensers, and on-board batteries. They provided a much better power-to-weight ratio and were more reliable than spark-ignition engines. They were also simpler mechanically and cost less to manufacture.

The Infant was an instant success. K&B soon introduced a slightly larger version with .035-cubic-inch displacement and then an .049. (The zero in these expressions is pronounced "oh." Thus, we say "oh-nine" for .09, "oh-four-nine," or "oh-forty-nine" for .049, and so on.)

Other companies — McCoy, Holland, Spitfire, and Testor — entered the ultra-small field. Competitions were set up. But what class would these new glow engines belong to? What else? Since they were about half the displacement of Class A engines, the new class became ½A. Any engine with a cylinder displacement up to .049 was classified ½A.

Cox began making model engines in 1950 and has always specialized in the smaller sizes. In 1984, the firm, after several changes of name and ownership, claimed to have manufactured more than 30 million engines. In fact, Cox engines — particularly the .020s and .049s — have dominated the ½A market for many years. For a time Cox even made a tiny, jewel-like .010.

Reed-valve and rotary-valve engines. There are two basic types of ½A engines. One type uses a rapidly vibrating metal or plastic reed to control the flow of fuel into the crankcase and then into the cylinder. Engine speed is adjusted by a simple needle valve. The Cox .049 Babe Bee, Golden Bee, and Black Widow are reed-valve engines. The other type has a venturi carburetor and a rotary-valve, variable-speed throttle — the Cox .049 Tee Dee and other Cox Tee Dees are rotary-valve engines.

There are two main reasons why each of the projects in this book is powered by a reed-valve engine. First, these engines come with a fuel tank mounted directly to the engine, greatly simplifying installation of the power plant. Second, most of the hundreds of thousands of old but still usable .049 engines lying around in attics and workshops are reed-valve engines. You may buy a new Cox reed-valve engine if you wish — they're sold by most hobby shops and by Sig Manufacturing Co. and several other mail-order firms listed on page 48 — but a used engine will do fine.

Mounting the engine is easy. Four lugs in the backplate allow small ½" wood screws to be inserted through the holes and screwed into a wooden plate or block — all of the projects use this mounting method.

Preparing to run the engine. If you have never operated one of these small engines or have bought a new engine that requires break in, mount it on a test stand and learn the tricks needed to make the engine run properly. What kind of test stand? Nothing fancy — the side of an old wooden box will do. Mount the engine so that the needle valve extends above the side of the box.

To operate the engine, you'll need (in addition to patience) fuel, a fuel bulb with fuel tubing, a starting battery, and a two-conductor wire with alligator clips or a specially designed clip on one end to connect the battery to the engine. If you use alligator clips, attach one clip to the glow head and the other somewhere else on the engine, usually to the stem of the needle valve. A specially designed clip attaches to the glow head and the cooling fins; the great advantage of a specially designed clip is that it can't short out.

Glow fuel contains methanol (methyl alcohol) and castor oil or a synthetic oil. Nitromethane ("nitro") is the most common additive; nitro increases power and makes the engine easier to start. The castor oil or synthetic oil provides the engine's only lubrication.

Although you can mix your own fuel, I don't recommend doing so. Buy fuel made by Cox or some other reliable manufacturer. For the engines and projects in this book, the fuel should contain 10 to 15 percent nitromethane.

Fuel bulbs are rubber syringes with a hollow needle over which a length of fuel line tubing can be fitted. The tubing should be long enough to reach the bottom of the fuel can so you can suck fuel into the bulb. Also, the tubing should fit tightly onto the nipple on the tank so that fuel won't leak around the edges of the nipple when you force it into the tank.

The starting battery is usually a 1.5-volt dry cell made by Eveready, Burgess, or Ray-O-Vac. The cylindrical No. 6 dry cell is an old favorite; a smaller, square type called a hobby battery is

also popular. Many hobbyists use a rechargeable nickel-cadmium (nicad) starting battery. Nicads produce about 1.2 volts, slightly less than a dry cell, but there's less voltage drop when the nicad is shorted across the glow head, so they work just as well — as long as they are charged.

Disassemble and thoroughly clean an old engine. To take it apart, you need only a small screwdriver and pliers. If you still have or can obtain a stamped-metal wrench that was specially made for use with that engine, so much the better.

Remove the tank from the crankcase. Make sure the internal fuel line is clean and that it is properly located for the application you have in mind. If you'll be using the engine for any of the projects in this book other than the Blue Angels, place the end of the tubing at the lowest point in the tank. If you'll be flying the Blue Angels formation, which is flown in a circle on a tether, place the end of the fuel line where it will be immersed in fuel when centrifugal force generated by the formation's counterclockwise flight pushes the fuel against the right side of the tank (as seen from the rear).

Unscrew the needle valve and remove any fuel residue. Inspect the reed valve and its retainer; flush out any dirt with fresh fuel. You should be able to move the reed valve around under the retainer — this ensures that the reed can breathe and feed fuel to the crankcase as the engine runs.

It probably won't be necessary to remove the cylinder and piston with its connecting rod from the crankcase and crankshaft. However, if the engine has been lying around for a long time and is frozen, put a drop or two of light oil or Liquid Wrench on the top of the piston and another drop in the exhaust opening. Free the piston by gently turning the propeller shaft. Don't twist hard — let the oil or Liquid Wrench do its work. If the piston doesn't free up and you then decide to remove the cylinder from the crankcase, don't squeeze the cylinder too hard or you could distort and ruin it. Be gentle. After all parts are clean, reassemble the engine and prepare to start it.

Starting the engine. If you still have the instructions that came with the engine, follow the starting procedure recommended in the instructions. Otherwise, observe the following procedure.

As I mentioned, first mount the engine on a test stand, which can be nothing more than an old wooden box or a block of wood. Use small wood screws passing through the holes in the backplate into the wood. The needle valve must be easily accessible from behind the engine.

Check that the propeller can rotate freely without striking the test stand or the surface on which the stand rests. Also, the test stand must be firmly secured because the spinning propeller will pull with more force than you might expect.

Check a used propeller for nicks or cracks; discard any prop with such defects. Next, make a simple prop balancer by supporting a single-edge razor blade on your workbench with modeling clay. Carefully set the propeller crosswise on the blade's cutting edge with the hole in the propeller centered on the edge when viewed from above. If the propeller is balanced, it will fall off slowly in either direction. If it consistently falls off in one direction, sand the heavy blade until the prop is balanced. This is admittedly a crude system, but it is good enough for the small props we are using.

A new propeller seldom requires additional balancing. Cox, Top Flite, and Grish make good props for ½A engines. The most commonly used props are five or six inches in diameter and have a pitch of three or four inches. Pitch is the angle of the blade of the propeller to its plane of rotation. The number — three-inch or four-inch pitch — is the distance forward the propeller would move in one rotation if it were screwing its way through a solid material like wood. In fact, that's the British term for a propeller — airscrew.

Make sure the propeller is held firmly on the shaft by tightening the propeller screw. Position the propeller so that it is horizontal as the piston comes up to compression. This is convenient for starting; it also ensures that the blades will be horizontal when the engine stops and will be less likely to break if the model noses over in a landing.

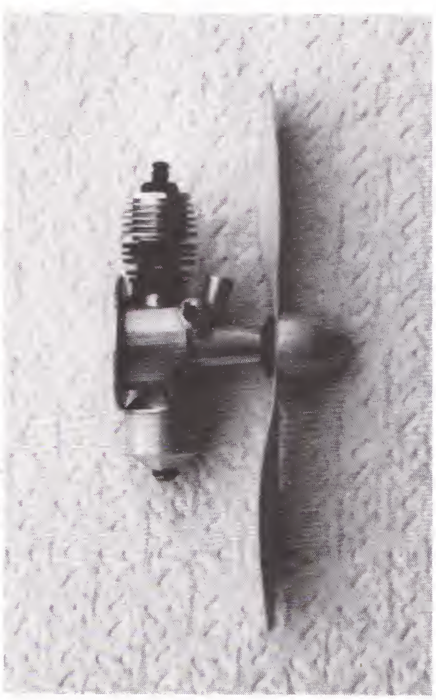
Screw the needle valve in until it stops — don't force it. Then open the needle valve three turns.

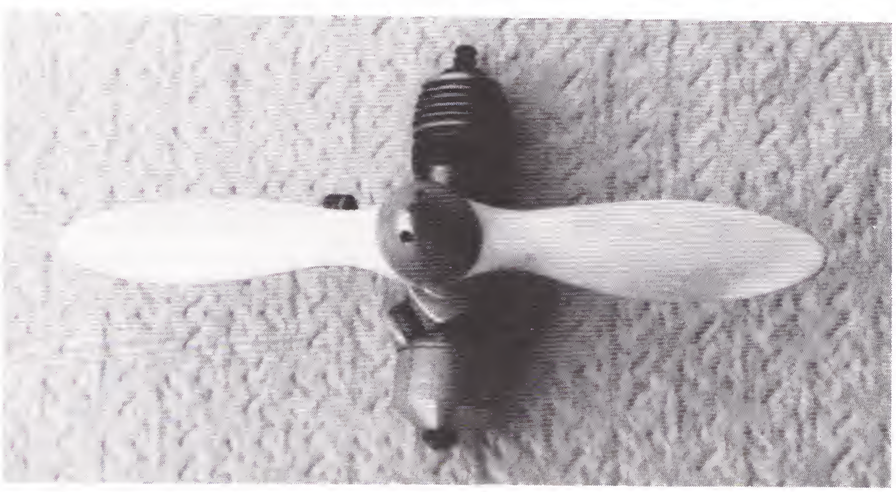
Fill the tank with fuel and attach the starting battery. Using an eyedropper, squirt several drops of fuel into the exhaust ports.

If your engine has a spring starter, slip the free end of the spring over one blade of the propeller, wind the propeller backwards (clockwise as seen from the front) about one turn, then release it, moving your hand quickly out of the way of the propeller's arc.

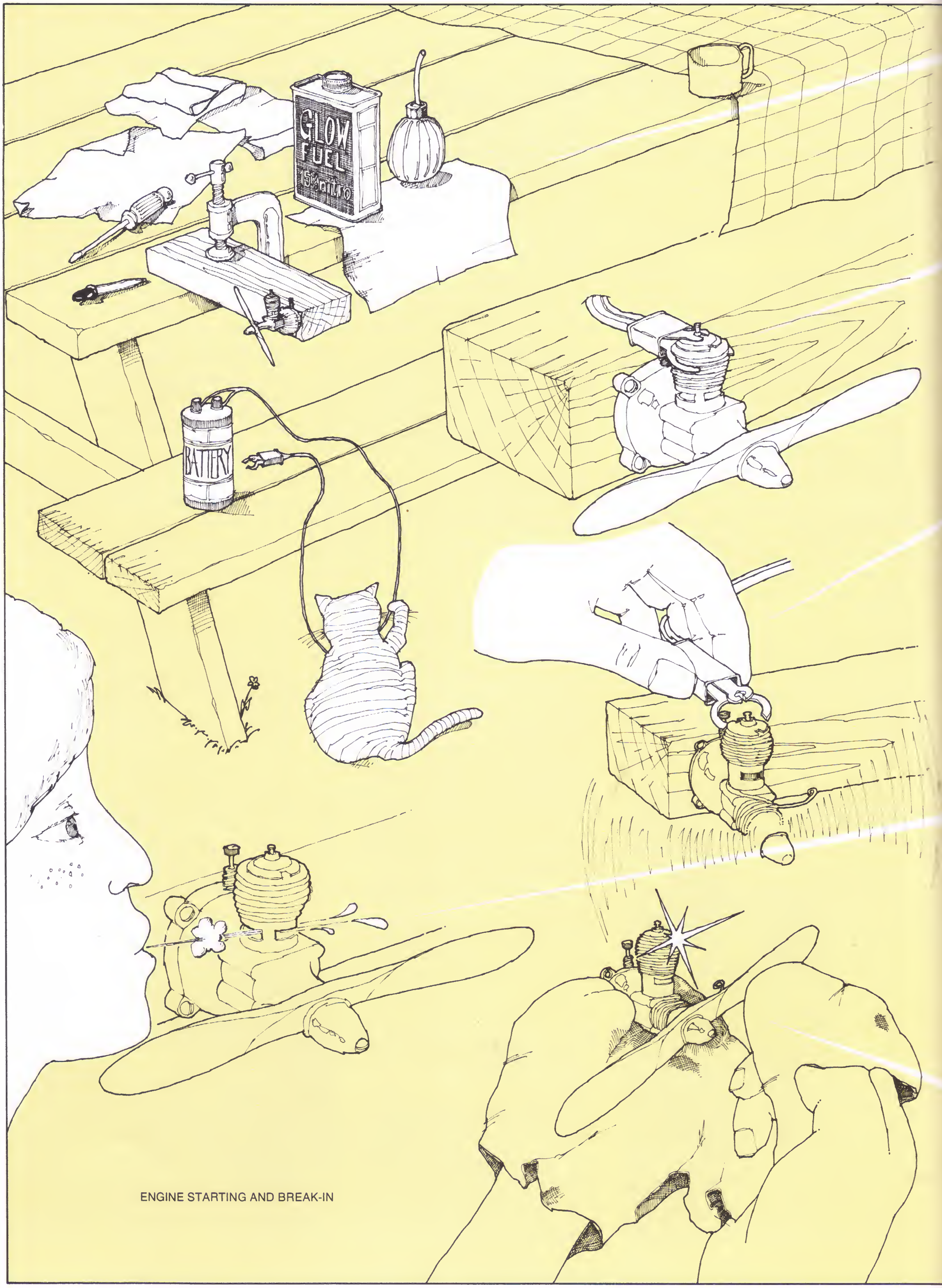
If your engine doesn't have a spring starter, smartly flip the propeller counterclockwise with the index finger of your right hand or (safer) with a small wooden stick. The engine should start. If it doesn't, try again. If it starts, runs for a short burst, then stops, open the needle valve about ½ turn, prime again with several drops of fuel in the exhaust ports, and repeat the procedure.

Unless you have one of the newer Cox engines with an improved spring starter, the engine may start and run backwards. If it does, close the needle





Front and side views of the 1949 K&B .020 Infant, the first ½A engine. The aluminum propeller was later banned by the Academy of Model Aeronautics as too dangerous. Our modern ½A glow-ignition engines operate on the same principles as the Infant.



ENGINE STARTING AND BREAK-IN

1. First gather these supplies and prepare a test stand for the engine.

2. Install the propeller so that its blade is horizontal when the piston comes up to compression. Fill the tank with fuel. Close the needle valve, then open it three turns. Prime the engine by squirting a few drops of fuel through the ports with an eyedropper. Connect the glow clip.

3. Wind the propeller one turn against the tension of the starter spring. Release the propeller. If the engine does not start, repeat. When the engine starts, slowly screw in the needle valve until the engine runs at top speed. Then back off the needle valve about a half turn so that the engine runs with a slight crackling or bubbling sound. Remove the glow clip. Let the engine run until the tank is empty. Repeat three times for a new engine. The engine is broken in when it consistently runs well after the glow clip is disconnected.

4. If the engine doesn't start after several attempts, open the needle valve another half turn and keep trying. If the engine doesn't start and you can see fuel running from the ports, it is probably flooded. Blow out the excess fuel, wait several seconds until you hear fuel sizzling in the cylinder, and try again.

5. After each test run or operating session with a model, let the engine cool for a few minutes, empty any remaining fuel from the tank, wipe off exhaust residues, and oil the engine with 3-in-One, sewing machine oil, or any SAE 10 oil. Then wrap it in a clean cloth or cover it with a plastic bag. At all times, keep in mind that engine must be clean internally and externally, the fuel must be fresh, and the starting battery must be strong.

valve to starve and stop the engine, then open the needle valve the same amount as before and flip again. Some modelers just throw a rag onto the prop to stop the engine. If you do so, check to be sure you didn't crack the prop. This procedure usually doesn't hurt anything but certainly isn't recommended.

The engine is running, but it sputters. Slowly turn the needle valve in; this will lean out the engine until the mixture of fuel and air is just right. If you go too far in, the engine will die for lack of fuel. Restart, adjust the needle valve until the engine runs steadily with a slight crackling sound, then back out the needle valve until the engine runs steadily without crackling. That should give full power.

Tip the engine up while running if you plan to install it in an airplane or one of the projects, such as a Spindizzy, in which the engine is mounted vertically. If the engine loses speed, back out the needle valve slightly until it runs steadily in the tipped-up position.

Troubleshooting a balky engine. There's one thing you can be sure of with a ½A engine — it won't run if there is even a speck of dirt in the fuel line. Oh, it will spit and sputter, but that's all. Keep your engine clean. If it gets dirty, disassemble it and flush the parts with fuel.

Be particularly careful to check the reed valve in its housing. That's where you'll usually find the bit of dirt that won't let the reed breathe and feed fuel properly. You may even have to remove the retainer to get at the dirt. If so, be careful. When you take out the retainer, it will expand slightly — and rapidly. If you don't restrain it, twang it goes, and you'll have a tough time finding it. Many a retainer has been lost that way.

If you have an older engine, the reed is thin metal; in newer engines it is Mylar plastic. In either case, be careful not to crease it.

There are other reasons the engine may not run properly or may not even start. Let's go through the most common problems, what causes them, and how to correct for each.

1. No ignition — glow head won't light up. Cause: low battery voltage, bad connection, or burned-out glow head. Check battery voltage; a dry cell should test 1.5 volts, perhaps dropping to 1.25 volts under the load of the glow head (no more!). A nicad should test about 1.2 volts. Replace a worn-out dry cell and recharge a low nicad.

If the battery is okay, check the leads to the glow head. Make sure all connections are tight. The coil of wire in the head should glow bright orange.

If the connections are tight, and the glow head doesn't glow, then it's burned out. Replace with a new head. Check the new one as well.

Here's something you can try if you're out in the field and don't have a spare glow head. Remove the glow head and connect the battery to it. Now, using a long pin such as a modeler's T-pin, carefully move the wire coil (which will probably be distorted) until it is once again centered. As you do so, the coil may suddenly light up. Stop right there. It's alive again. This is a delicate operation but you may get several more flights out of the glow head.

2. Engine won't start even though glow head glows. Cause: not enough fuel, or too much. Try priming again. If the engine runs briefly and quits, open the needle valve a half turn, prime, and repeat. If the engine was lean, it should now start.

If the engine is flooded, close the needle valve one turn and flip the prop several times. If it doesn't start and still expels fuel, rotate the propeller until the exhaust port is open and blow into the port to remove excess fuel. Let the glow head cook for a few seconds — you should hear the fuel sizzle. Then try to start the engine again. When it's running, readjust the needle valve for full power.

3. Engine pops and stops. Cause: the propeller came loose. Tighten the prop screw and start again.

4. Engine starts, kicks, and sputters, but won't run well. Cause: dirt under the reed valve. Disassemble the engine, clean the valve, and try again.

5. Engine runs weakly. Cause: loose glow head. Tighten the head and try again.

The foregoing problems and solutions are the most common. There are others, of course. Perhaps the engine has been in a crash and the propeller screw is bent. Check for a bent screw by flipping the prop and watching from the side. If one blade goes forward and one back, the screw's bent — replace it or carefully straighten the old screw.

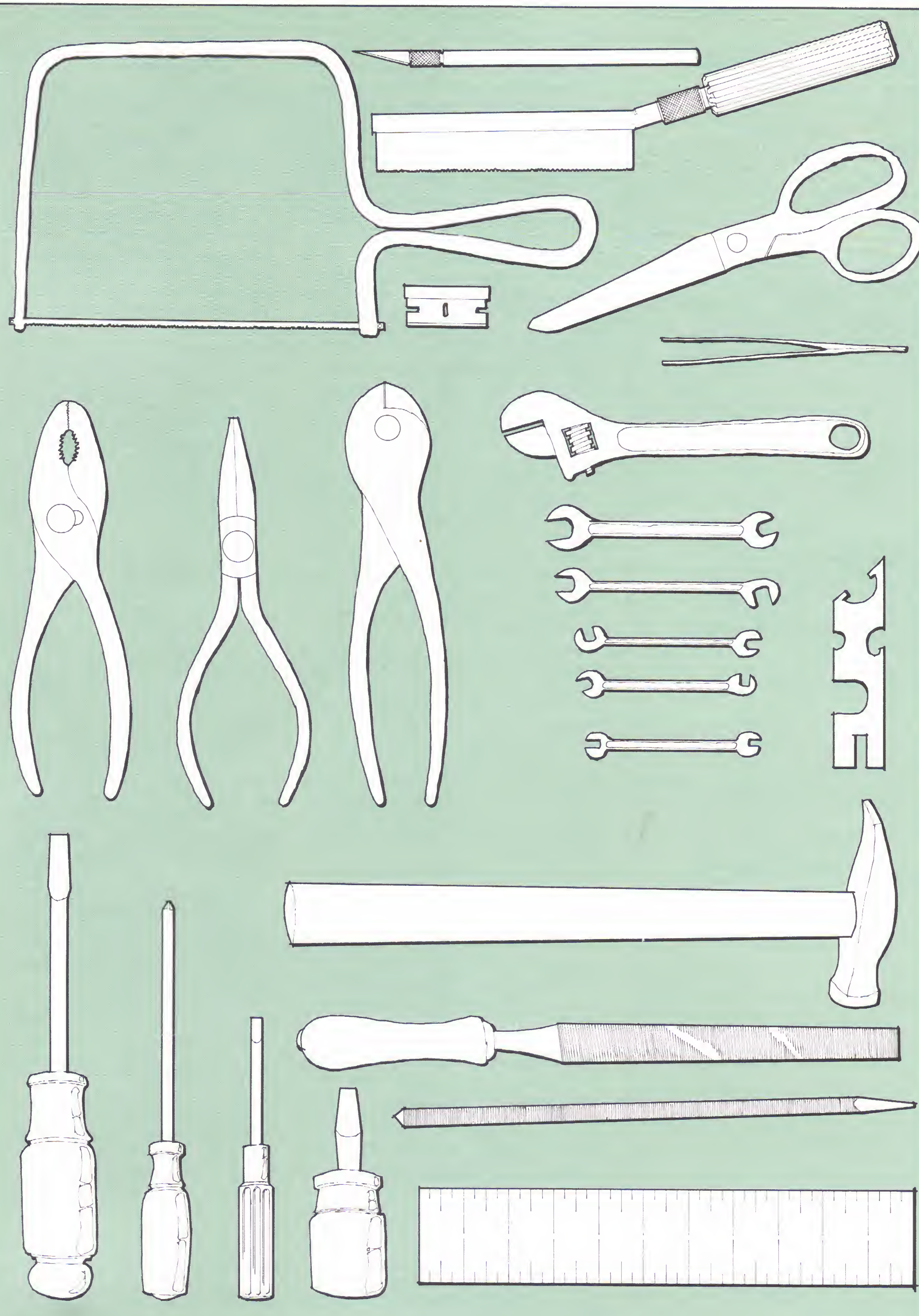
Another possible problem is that the engine has sat around, uncleaned, and the Mylar reed valve has swollen. Obtain replacement reeds from Cox or Davis Diesel Development.

Tools. None of the projects in this book requires an elaborately equipped workshop, although I have assumed that you own or have access to common household tools such as screwdrivers, pliers, and hammers. In addition, a few other tools are handy.

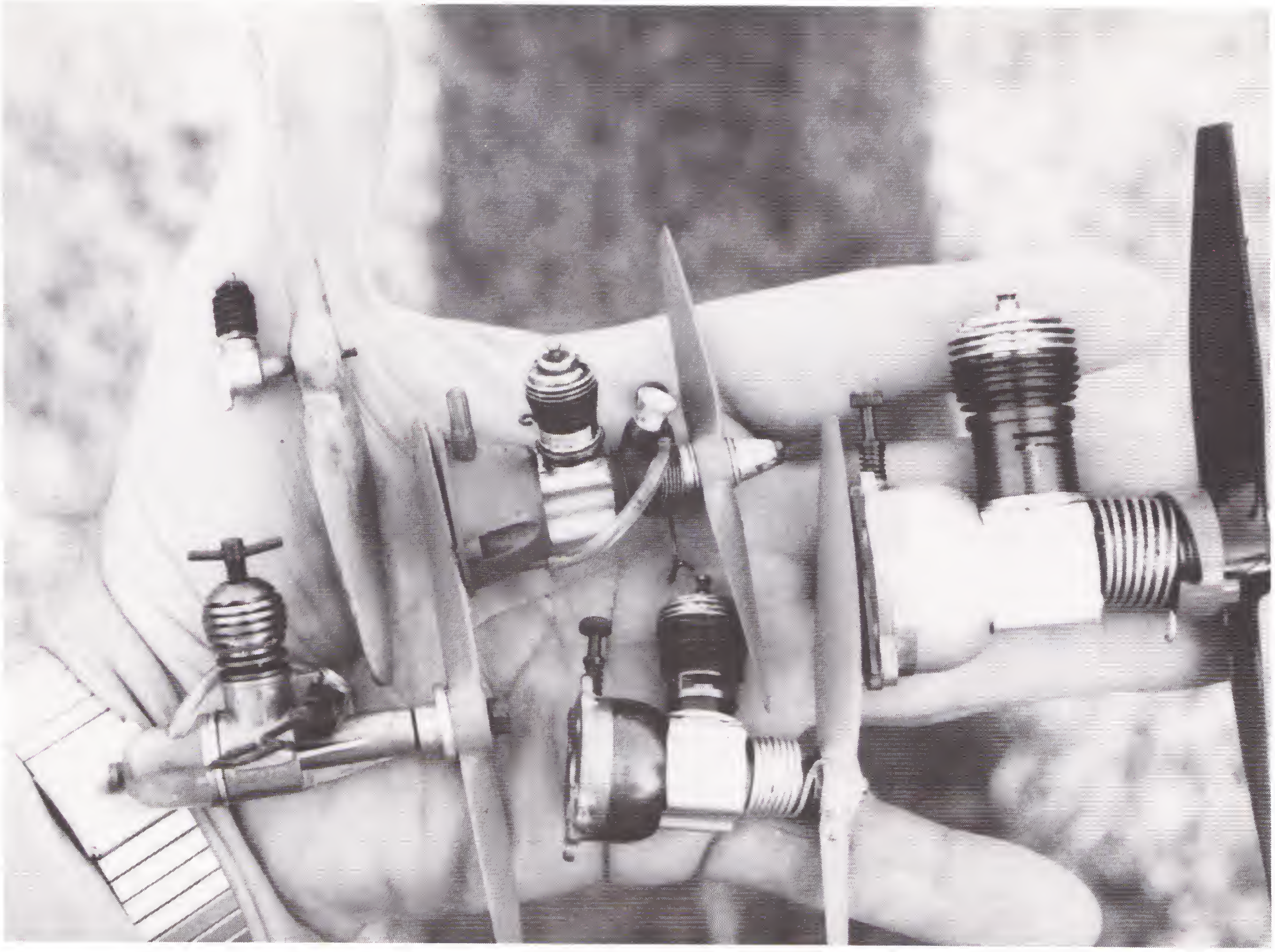
Perhaps the most desirable special tool is the Cox .049 engine wrench, a stamped-metal wrench specially designed for removing the glow head, cylinder, and other parts on any Cox ½A engine.

Single-edge razor blades are useful for cutting and carving balsa and cutting foam-core boards such as the Aerolite Foamboard used in the Roamin' Rhombus and Blue Angels projects.

An X-acto knife with a No. 11 blade is frequently required; inexpensive re-



MODELING TOOLS



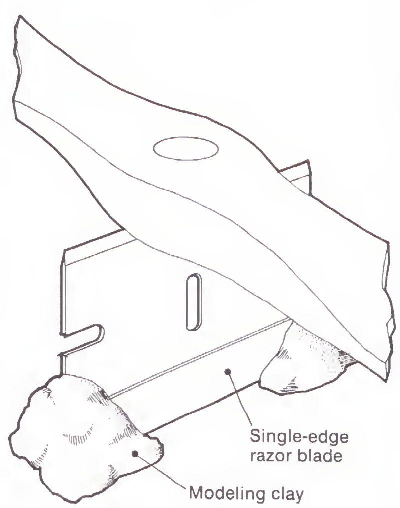
A handful of small engines from over the years. At top left is a Brown Campus motor driven by compressed carbon dioxide, at bottom left is an English Bambi .009 diesel. The other three are Cox glow-ignition engines — an .010 Tee Dee at top center, an .020 Pee Wee at bottom center, and an .049 Babe Bee at right. The engines are shown approximately actual size.

placement blades are made by X-acto and several other firms.

The X-acto and Zona razor saws are also convenient. These have a very thin, replaceable blade with fine teeth; the Zona saws can even cut soft metals such as aluminum and brass as well as wood.

Several of the projects require that you cut and bend tempered steel wire, called music wire or piano wire, when making landing gear struts. Cut music wire only with a metal file or cutting wheel on a motor tool such as the Dremel Moto-Tool. Music wire is so tough that it will ruin the edges of other tools.

Materials. Balsa is the most widely used construction material for flying models, although plastics are being used increasingly as the price of balsa continues to rise. Even so, balsa is king. Balsa trees grow in South American rain forests, primarily in Ecuador. The wood ranges in weight from as little as two pounds per cubic foot to twelve pounds per cubic foot. Balsa's strength is roughly proportional to its weight, so selecting the right grade of balsa can make a big difference in the weight and strength of any model. Hobby shops and mail-order firms sell an astonishing variety of balsa blocks, sticks, sheets, and even wedge-shaped trailing edge stock.



If the prop consistently falls off in one direction, sand the heavy blade until the prop is balanced.

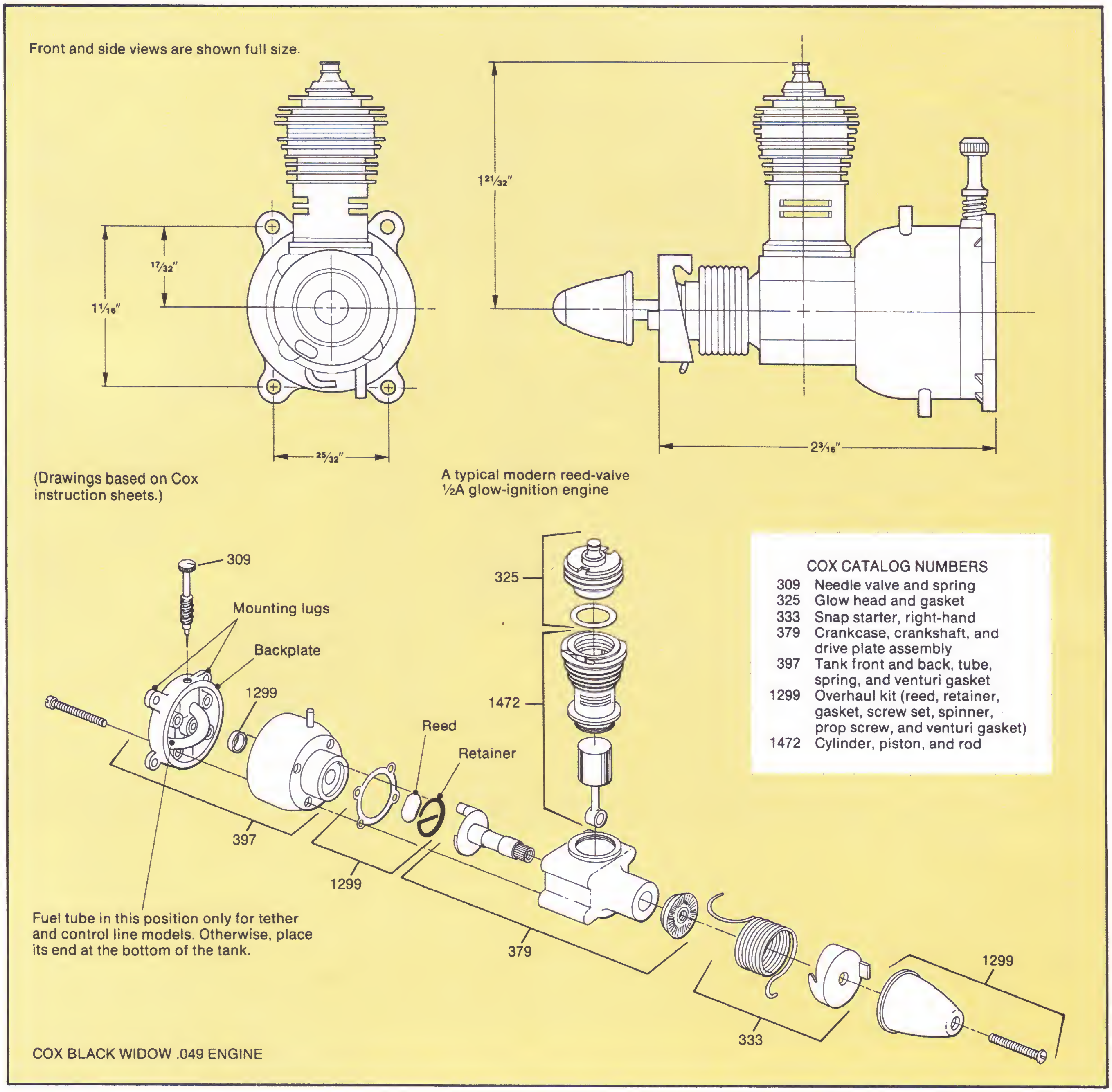
SIMPLE PROPELLER BALANCER

The projects in this book that require balsa are designed to use a medium grade — around five to six pounds per cubic foot. How do you tell? Feel the balsa; if it is soft and can be compressed by squeezing it between your fingers, it's too light. If it's rock hard, it's too heavy. Not to worry; most balsa sheets and strips are of the medium grade anyway.

Balsa's not strong or dense enough for engine mounting blocks and bars, so the projects use basswood, spruce, maple, or pine for these parts.

Wood dowels, available in 36″ lengths at most hardware stores, have a variety of uses in modeling. For example, in a couple of the projects in this book, $\frac{3}{16}$″ dowels are used as leading edges for Foamboard flying surfaces. In several projects, dowels serve as wing hold-down pins.

Two of the projects, the Roamin' Rhombus and Blue Angels, are made of a special foam-core board, Aerolite



COX BLACK WIDOW .049 ENGINE

Foamboard. Most foam-core board consists of a styrene foam core that is covered on both sides with high-quality paper; the Aerolite product is coated with .004" ABS plastic instead. If for any reason you can't obtain Aerolite Foamboard, you should be able to order similar plastic-coated foam-core board from plastics stores such as TAP and most art supply stores.

Adhesives and paints. This is not the place for a thorough discussion of glues and paints, so I'll mention only a few of the hundreds now on the market.

White glue such as Elmer's Glue-All is excellent for gluing wood and foam plastic but is difficult to sand, so wipe away any excess before it dries. Aliphatic resin glues such as Titebond are similar to white glue but are a little easier to sand.

Epoxy glues are packaged in two parts, resin and hardener, which you mix immediately before use. Drying time (actually curing time, since the resin and hardener polymerize) ranges from less than five minutes to more than a day depending on the formula. In these projects, you'll use 5-minute epoxy for extra-strong bonds on wood and plastic parts and as a fuel-proofer on engine mounts.

Finally, there are instant glues — Hot Stuff, Zap, Jet, Krazy Glue, and others. These cyanoacrylates range in viscosity from watery to honey-like and their drying times vary from a few seconds to more than a minute. Instant glues dissolve plastic foam but the brands sold in hobby shops are excellent for bonding most other materials and greatly speed up model building.

Only a few of the projects in this book require painting; for those that do I suggest Pactra Formula U or some other polyurethane or epoxy paint that won't attack plastic and that is fuel-proof.

Safety. There is a well-known axiom, "Safety is no accident." You can interpret that several ways, but what it says, basically, is that if you take care, safety is maintained, and if you are careless, an accident may, and usually does, result.

For example, a single-edge razor blade should almost always be used with the cutting edge pointed away from your body. Otherwise, a slip could let the blade slice right through your shirt, jacket, or flesh. Ouch!

True, there are times when a cut has to be made towards your hand as you

The 1.5-volt No. 6 dry cell is about as tall as a quart can of fuel and has long been favored by ½A engine operators. Smaller dry cells such as flashlight batteries either cannot deliver enough current to heat the glow head or rapidly become exhausted. A No. 6 cell often lasts an entire flying season. Connect two cells in parallel for even longer life.

hold the object being worked on. If so, brace the hand holding the razor blade against the working surface and move the blade only with your thumb and forefinger.

Be careful that pliers or wire cutters don't lose their grip, snap shut, and pinch your skin.

If you are using a razor saw or some other small handsaw, keep the kerf open by pressing the material in the direction of the cut. This prevents the blade from seizing and possibly buckling and cutting your hand. No need to tell you to be careful with a hammer, is there? We all learn the hard way about hammers and thumbs.

Heed the safety warnings on adhesive and paint containers. Be especially careful when working with one of the instant glues. They bond flesh in a flash. Never point the application nozzle anywhere near your face.

Be certain your workshop is adequately ventilated. The glue and paint fumes may not be toxic, but can be unpleasant. Never run engines indoors.

Treat glow fuel like the potential explosive it is. Keep it in its original container and store it in a relatively cool area away from heat sources such as a furnace, water heater, or an electric light. If you are using a fuel bulb, never point the tube towards your face — fuel in the eyes is very painful.

Perhaps more accidents occur when starting a model engine than at any other time. That spinning prop has sharp edges. The odds are, no matter how hard you try to avoid it, that sooner or later you're going to get your fingers rapped. That doesn't hurt much if the prop hasn't come up to speed, but if the engine is running all out — say 10,000 rpm — it smarts. Be alert!

All of the projects in this book are intended to fly, float, or run — and fairly fast. If they aren't adjusted correctly, they could turn on you shortly after launch. You must be ready to duck the first few times until you get the model working properly (although you'll have to watch the Spindizzies all the time, because they go every which way).

Also, pick a good operating site. Stay away from as many obstacles as you possibly can — in particular telephone wires, power lines, and fences. Choose an open field for the flying machines, a big pond for the Puddle Jumper, a large paved or grassy area for the Spindizzies.

Finally, all of these projects attract spectators. You know what to expect, but they won't. Warn them to be alert and don't let them get too close.

That's enough pontificating. Everything said here is nothing more than "Hey, use good sense, and you won't get hurt."

Project 1

The Fantastic Ragtime Flying Machine

Up to this point, I've been telling you how the ½A engine originated, how it operates, and what you need in the way of tools and materials to build models. Now let's get something into the air.

When you first read about the Fantastic Ragtime Flying Machine, you may not believe anything so outlandish could fly. Have faith. It does work — you'll be amused and amazed by it and your friends will first think you're crazy, then they'll laugh and want to know how to make one for themselves!

Construction. Now to construct the Fantastic Ragtime Flying Machine. The most difficult part is sawing the block of wood on which the engine is mounted. Even that is easy if you use basswood. Maple is too hard; pine is okay, but basswood is best.

Mount the engine to the block with four ½″ wood screws. Using a screw at each of the mounting lugs on the engine's backplate reduces the chance of any of the lugs breaking in a hard landing — yes, all landings are pretty hard. However, if the engine already has one or more broken lugs, just use two or three screws and hope for the best.

Next, tie an overhand knot in one corner of each shop rag and pull the knot moderately tight. Now, using the two thumbtacks, attach the shop rags to opposite sides of the engine mounting block. Although it's not critical, push the tacks through the rags at about the same distance from the corner to help balance the machine.

For best flight characteristics, adjust the knots by holding the engine mounting block with the engine pointed straight up and tighten the knots so that they are roughly the same distance from the block when hanging vertically.

Flying. All set? Let's launch the Fantastic Ragtime Flying Machine. Wait for a calm day because when this ma-

The Fantastic Ragtime Flying Machine will perform differently each time you launch it — note the varied angles and tangles of the rags in these photos. In each case, though, the rags soon straightened out and the machine ascended vertically.

chine goes up, it goes way up! If there's any wind, it will drift downwind, perhaps so far that you'll lose it.

Fill the tank and start the engine, then set the needle valve to peak power. Point the engine up and let it run for about 20 seconds. If it sags when held vertically, adjust the needle valve as needed.

When the engine is running steadily, launch the Fantastic Ragtime Flying Machine by gently pushing it straight up and letting go. When it leaves your hand, it will immediately start to twist the rags in the opposite direction to the rotation of the propeller. Then, as the rags twist together, the knots at the bottom will begin to spin outwards, acting as a governor and stabilizing the rotating rags at a constant speed.

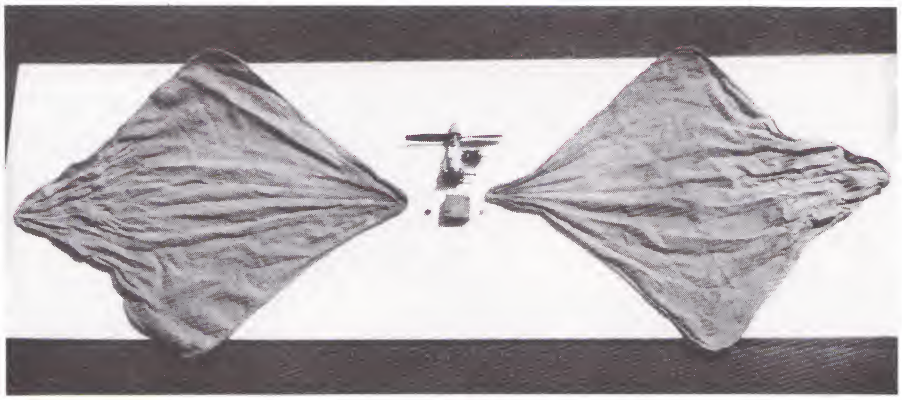
Up, up, and away she goes! Of course, you'll get all sorts of flight patterns. Sometimes the rags become tangled unevenly and then the flight is pretty wild, so keep an eye on the unit at all times. Also, there will be times when the engine doesn't run right even though you adjusted it properly. This is because the rate of fuel feed changes slightly when the engine starts to spin. You may have to experiment a bit before you get the right needle valve setting for the spinning condition. When you do, you'll find that the Fantastic Ragtime Flying Machine will almost disappear overhead unless you limit the engine run.

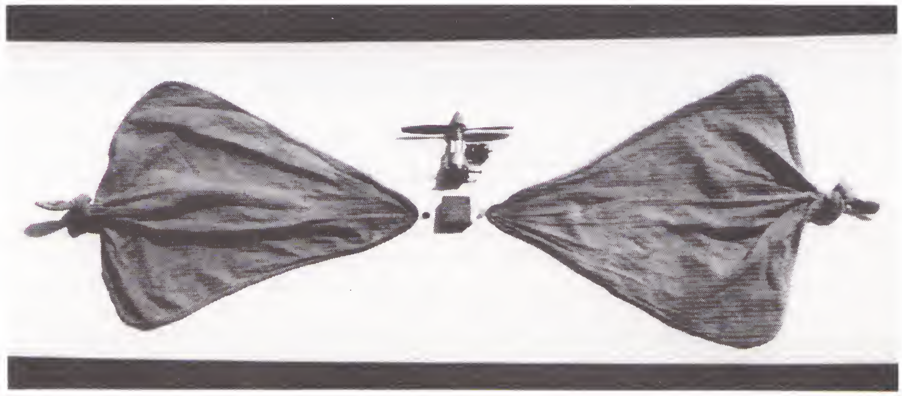
When the engine quits, the unit comes down engine first with the rags trailing upwards. They reduce the falling speed, but even so don't fly the machine where it might land on a hard surface. A grass field is best. Avoid plowed or bare fields; dirt would get into the engine and you would have to clean it out in between flights.

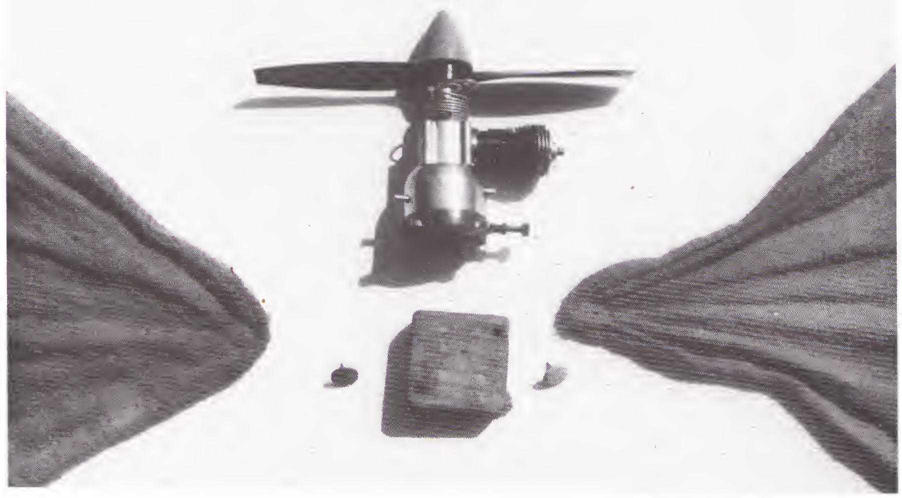
The Fantastic Ragtime Flying Machine may be silly, but who cares? It's a lot of fun and doesn't cost a fortune. That's pretty hard to beat.

Bill of materials

- A piece of hardwood ½" x 1¼" x 1¼"
- Two thumbtacks
- Two mechanic's shop rags
- Four ½" wood screws







(Top) If your local automobile mechanic isn't willing to part with a couple of shop rags, you can buy them at most auto parts stores or from any industrial towel service. (Second from top) Tie a moderately tight overhand knot at the "trailing edge" of each shop rag. (Third from top) I'll soon mount the engine to the block with four ½" wood screws through each lug on the backplate. (Bottom) The Fantastic Ragtime Flying Machine is now ready for flight. Grasp the block firmly when starting the engine and watch out for the prop!

Project 2
The Flingthing

The Flingthing is only slightly more complicated than the Fantastic Ragtime Flying Machine and the flight pattern is similar in that it spins into the air, climbing until the engine stops.

As with most flying machines, the Flingthing is not a new design. It was developed in 1959 by a modeler named Ernst Skirde. He called it the German Saucer, but that wasn't very descriptive. When someone asked "How do you launch it?" the answer was "Fling it in the air with a twist." Thus the name Flingthing.

Let's get all the parts lined up and assemble one of these unusual flying machines. The Bill of Materials on page 14 lists the few items you'll need.

Construction. Follow this 13-step construction sequence.

☐ 1. Cut out a cylinder, 6″ in diameter and 2″ high, from the plastic bottle.

☐ 2. Cut two lengths of the 1/16″ music wire to 22″ long.

☐ 3. Drill four holes in the side 1/2″ up from the bottom edge of the plastic cylinder; the wires will pass through these holes at right angles to each other, intersecting at the center of the cylinder. You can drill these holes easily by rotating the sharp end of an X-acto knife blade against the plastic. Be careful not to enlarge the holes too much — they should be just large enough that the wire can be gently forced through.

☐ 4. Bend the wires down approximately 15 degrees at the points where they pass through the cylinder wall. The actual angle is not critical but it should be the same at all four intersecting points. Mark the center of the wire, come out 3″ either way, and make the bends. The tips will be bent down 2″. Lay both wires together and check that the bends are uniform.

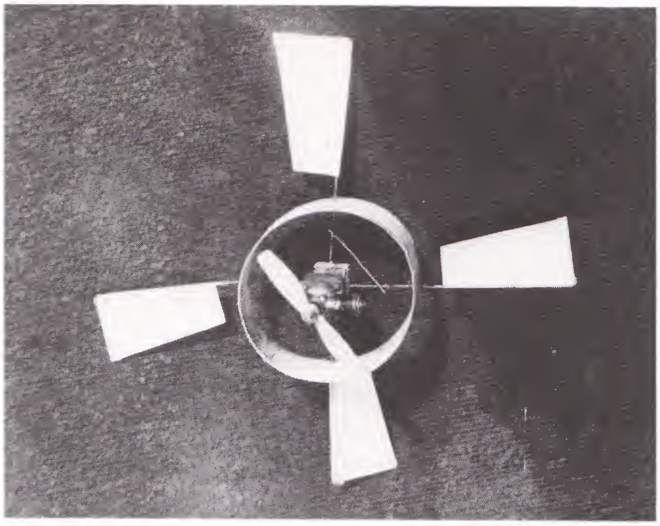
☐ 5. Insert the wires through the holes in the cylinder.

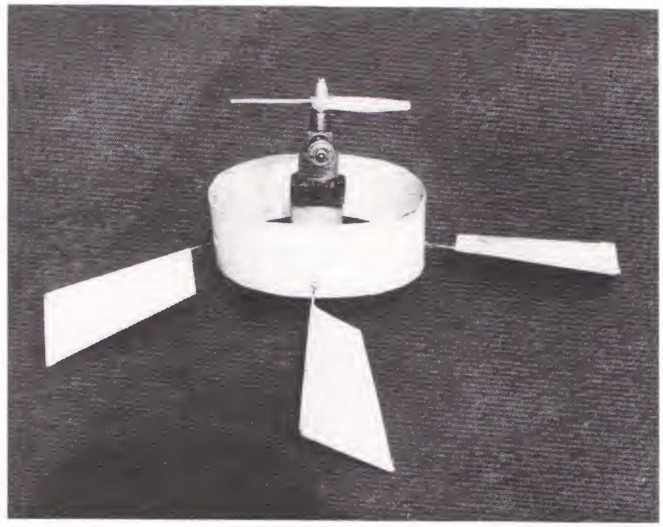
☐ 6. Cut right-angle grooves in the 1/4″ x 1 1/2″ x 1 1/2″ balsa block for the wires. The grooves should cross at the center of the block and should be deep enough that the wire is flush with the surface. That means each groove will be 1/16″ deep at the edge and 1/8″ deep at the center where the wires cross.

☐ 7. With the wires centered, glue the 1 1/2″ balsa cube to the 1/4″ x 1 1/2″ x 1 1/2″ balsa block, capturing the wires.

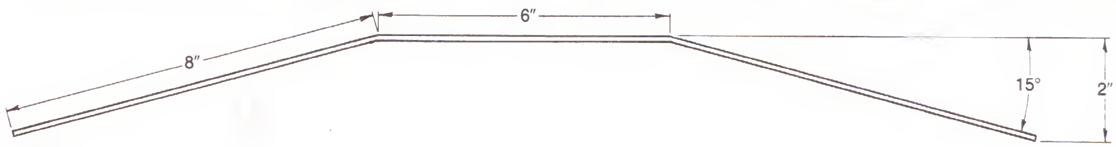
☐ 8. Bend the ends of the wires so that they will set the Flingthing's blades at the correct angle. About 25 degrees, give or take a couple of degrees, seems to be best. This is the toughest part of the construction — not because the wire is hard to bend, but because you want to bend each wire the same amount. Come in 2 1/2″ from the end of the wire, grasp it firmly with a pair of pliers, and then bend the wire until its end is down 1 1/4″ from the bottom edge of the cylinder. Do the same for the other three wires. Be sure to bend the wires in the direction shown in the drawing.

Launch the Flingthing with a twisting action of your wrist, as if you were screwing the machine into the air.

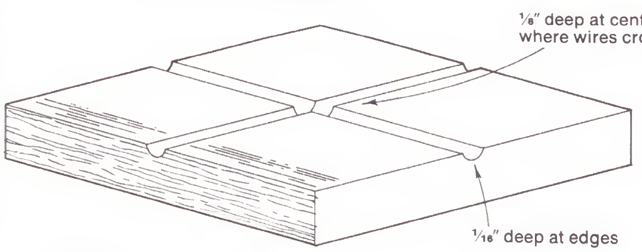




Top and side views of a completed Flingthing reveal its simple structure. Fast-setting epoxy glue is the best adhesive to use on this model; epoxy is strong, fuel-proof, and bonds wood, metal, and plastic. Coat the engine mount with epoxy after assembly.

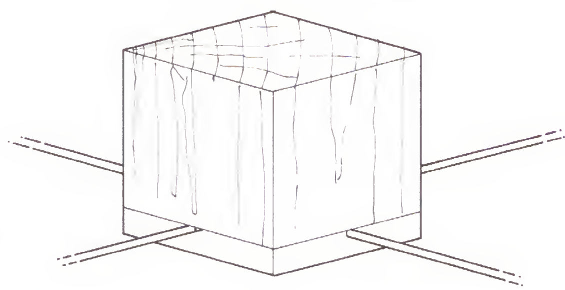


STEP 4
Bend the wires as shown.



STEP 6
Cut grooves in the balsa block for the wires.

STEP 7
Capturing the wires between the blocks



☐ 9. Cut four blades from the 4″ x 9″ piece of 1/16″ sheet balsa. Each blade is 4½″ long, 2½″ wide at the tip, and 1½″ wide at the inner edge.

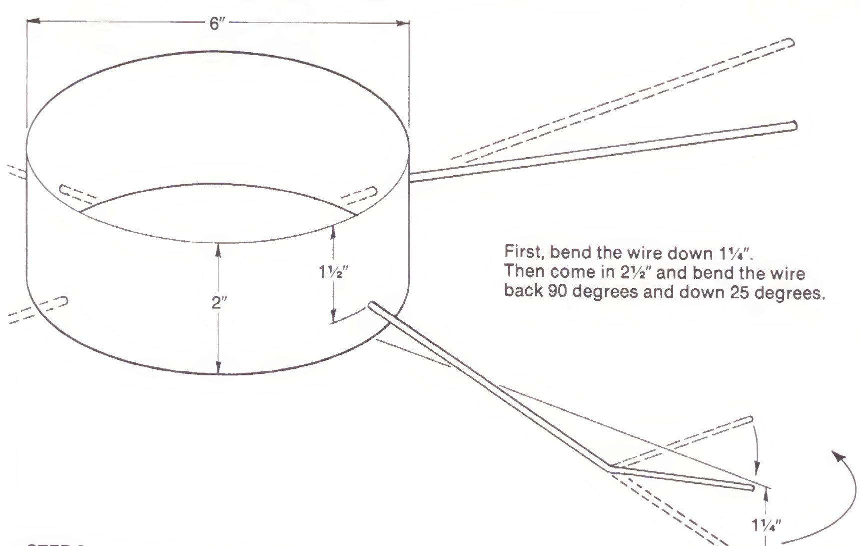
☐ 10. Glue the blades to the wires.

☐ 11. Glue the ½″ x 1½″ x 1½″ basswood engine mounting plate to the end of the balsa cube. Round off the corners if you want to dress up this center post assembly a bit.

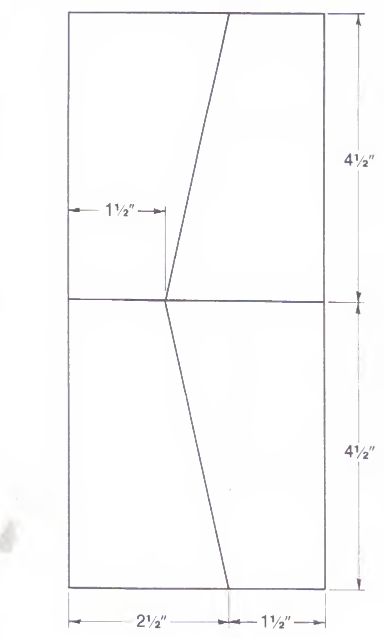
☐ 12. Paint the entire unit to suit your taste or leave it bare.

☐ 13. Mount an .049 engine to the mounting plate with four ½″ wood screws and you are ready to fly.

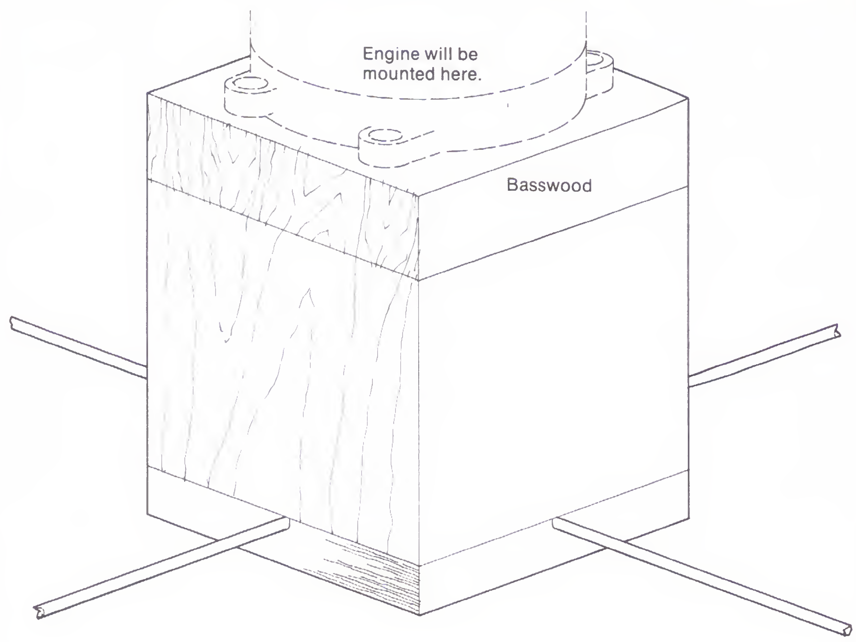
Flying. To launch, start the engine and adjust the needle valve so that the engine runs smoothly with the machine's nose pointed straight up. In order to prevent the Flingthing from flying out of sight, limit the engine run to less than 60 seconds. Either only partially fill the tank or completely fill it and let the engine run for about a



STEP 8
Setting the wires at the correct angle



STEP 9
Cutting the blades



STEP 11
Gluing the basswood engine mounting plate to the balsa block

minute before launch. Also, as with the Fantastic Ragtime Flying Machine, you may find that, due to the rotation after launch, the engine doesn't run smoothly. Experiment until you find the correct setting.

The launch itself is simple. Hold the Flingthing at the center post with the base of the post between your thumb and two fingers. You'll feel the unit trying to rotate opposite to the direction of rotation of the propeller.

Hold the Flingthing vertically, twist your wrist in the direction which the machine wants to rotate, and throw the Flingthing straight up. Keep a wary eye on it in case the engine sags and it falls back. If the engine runs properly, the Flingthing will spin rapidly upward until the engine quits.

Ideally, the Flingthing will turn over and start to spin in the opposite direction when the engine quits, descending slowly. However, the Flingthing is seldom perfectly balanced and usually tumbles down. The reason is that the falling machine spins faster and faster and becomes a gyroscope. If the balance point is not exactly centered, the offset balance causes the gyroscope to precess, or gyrate. When this happens, the Flingthing turns right side up, stops spinning, and tumbles. It may do this several times on the way down. Fly over a grassy field and the Flingthing won't be seriously damaged when it lands.

You can try to balance the Flingthing perfectly by adding small lead weights to the plastic cylinder on the side opposite that faced by the engine cylinder. If these weigh the correct amount and are properly located, the Flingthing will flip over after the engine quits and rotate faster and faster, finally turning so fast that it will descend slowly like a maple seed.

In any case, whenever you go out to fly the Flingthing, you'll attract a crowd of spectators who will watch in fascination as it spins skyward.

Bill of Materials

- An empty plastic one-gallon detergent or bleach bottle, such as Clorox
- Two pieces of 1/16" music wire, 36" long. That's more than is required, but music wire only comes in 36" lengths.
- A 4" x 9" piece of medium-weight 1/16" sheet balsa
- A 1½" balsa cube
- A ¼" x 1½" x 1½" balsa block
- A ½" x 1½" x 1½" basswood block
- 5-minute epoxy glue, instant glue, or some other high-strength adhesive

Project 3

The Sunday Flier

The Sunday Flier is just about the easiest free flight sport model airplane you can build. All parts of an airplane must be accurately aligned and wing alignment is the most important — few beginning modelers can construct warp-free wings — so the Sunday Flier uses ready-made plastic foam wings. That feature, combined with a solid balsa fuselage, ensures an accurately built model.

The Bill of Materials lists everything you'll need in addition to glues and paints.

Full-size plans (No. 12813) for the Sunday Flier are available from *Model Builder* magazine (address on page 48).

Construction. First study the plans and photos. Note that the fuselage is made from two 1″ x 1″ x 36″ balsa sticks, plus two small pieces of hardwood to mount the motor.

The 3/16″ dowels are holders for the rubber bands that secure the wings and tail assembly. Under normal conditions the rubber bands hold the wings and tail securely in place but allow these parts to pop free in a crash, often preventing damage.

One of the 1″ x 1″ x 36″ balsa sticks serves as the primary structure for the fuselage. The horizontal stabilizer is an Ace foam wing panel, which has a symmetrical airfoil, so the first step in fuselage construction is to trim the tail end of the balsa stick to form a cradle for the horizontal stabilizer. Place one end of a wing panel at the tail of the balsa stick, making sure that the center line of the panel's airfoil section is parallel to the top edge of the stick. Mark the curve on the balsa with a pencil and cut out the cradle, being certain to cut straight across so that the cradle will hold the stabilizer level.

Cut out the 19″ underbelly piece from the second 1″ x 1″ x 36″ balsa stick. Next cut two wing cradle pieces from the remainder of this stick and then cut one of these pieces in half lengthwise — you'll end up with one 1″-wide cradle piece and two 1/2″-wide pieces. Note that the cradle pieces will hold the leading edge of the wing higher than the trailing edge. This gives the correct angle (called the angle of incidence) of the wing relative to the fuselage and the horizontal stabilizer.

Now glue the underbelly to the main fuselage stick, with the forward ends in line.

Glue the 1″-wide wing center cradle piece to the top of the main stick, locating it at the position shown on the plans. Glue the 1/2″-wide side cradle pieces to the center cradle piece, locating the top edges of the side pieces about 1/8″ higher than the top of the 1″-wide piece. You'll later carve and sand the top of the cradle to match the dihedral angle of the wings.

Glue the 1/4″ x 1/2″ x 1 1/2″ hardwood engine mounting pieces to the sides of the fuselage at the nose. Trim these mounting pieces to provide several degrees of engine down thrust. The down thrust causes the slipstream (the air pushed back by the propeller) to flow in such a way that the nose of the model doesn't rise too high when the engine is running, which would cause a stall.

The fuselage is now complete, except for the dowels and final shaping.

Each wing is made of two panels glued to each other at the precut 3-degree dihedral angle; the left and right wings are glued together at the center. First glue the center panels together with 5-minute epoxy. Brace the panels until the glue dries or hold them if you're the patient type — in either case make certain they don't slip out of alignment. Then glue on each of the outer panels, again using 5-minute epoxy.

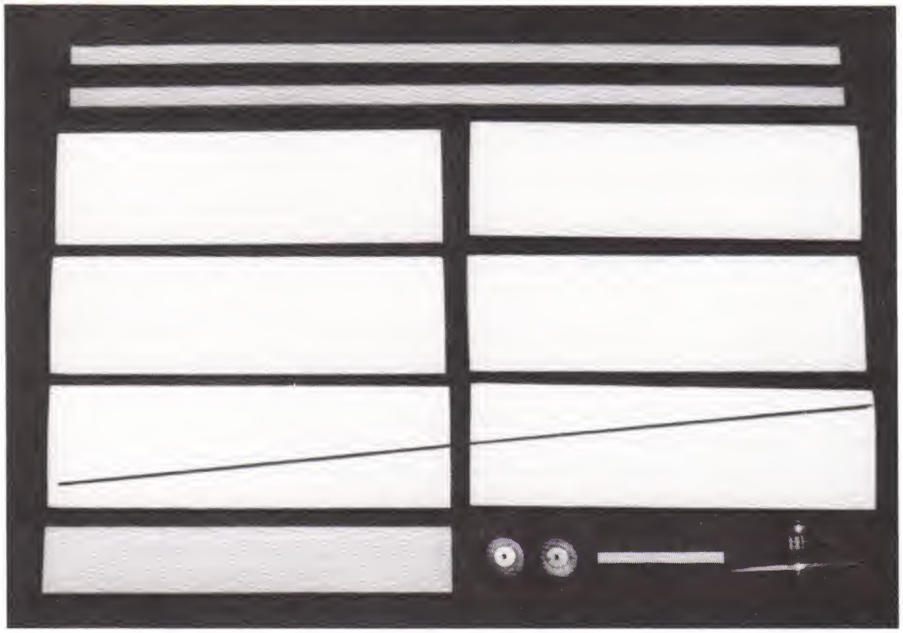
After the glue has dried completely, cut a 3/16″-deep notch in the trailing edge extending 2″ from both sides of the wing center joint. Epoxy a 4″ piece of 3/16″ dowel in the notch after first nicking and cracking the dowel in the center so it will match the dihedral angle. Smear epoxy along the top and bottom of the center joint, extending the glue out about an inch on either side. Before the epoxy dries, wrap a piece of strapping tape completely around the center joint.

Finally, run a piece of strapping tape along the bottom of the wings from wing tip to wing tip.

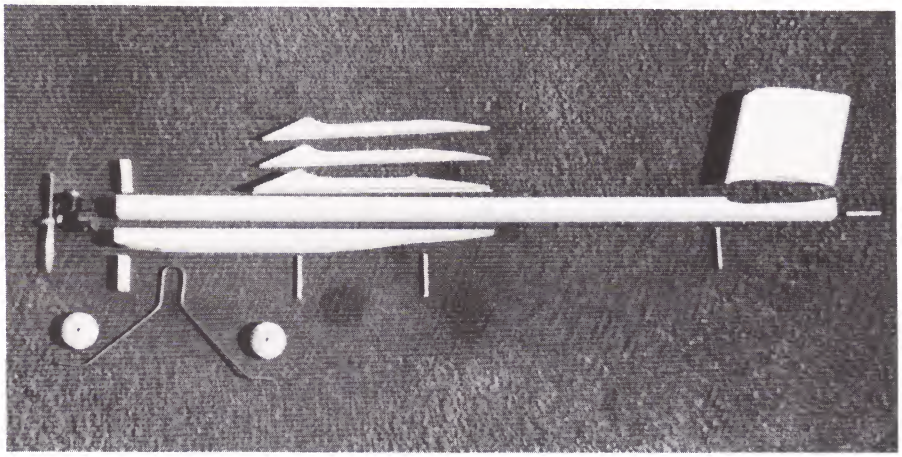
The wings are now complete except for painting or covering.

The vertical stabilizer, or fin, is made of 1/8″ sheet balsa. Using a single-

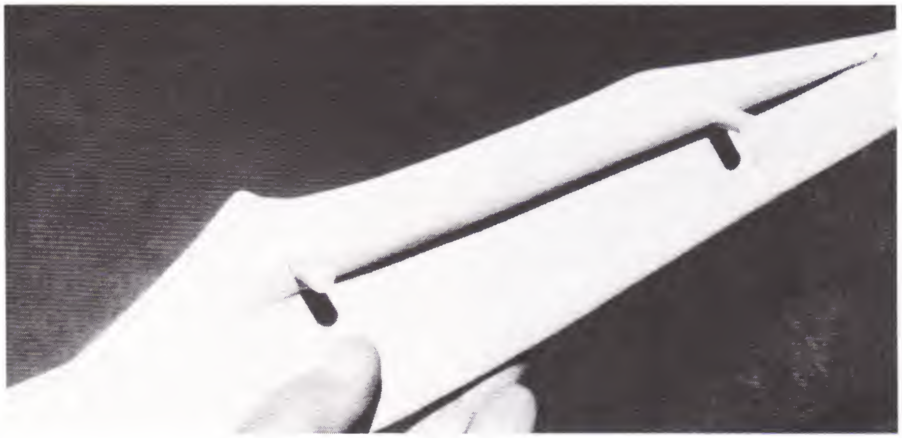
The Sunday Flier spans 68″ and is 39″ long, including the engine. It's not a scale model, though it does resemble a real airplane more closely than any other project in this book. Rubber bands hold the wings and tail to the fuselage.



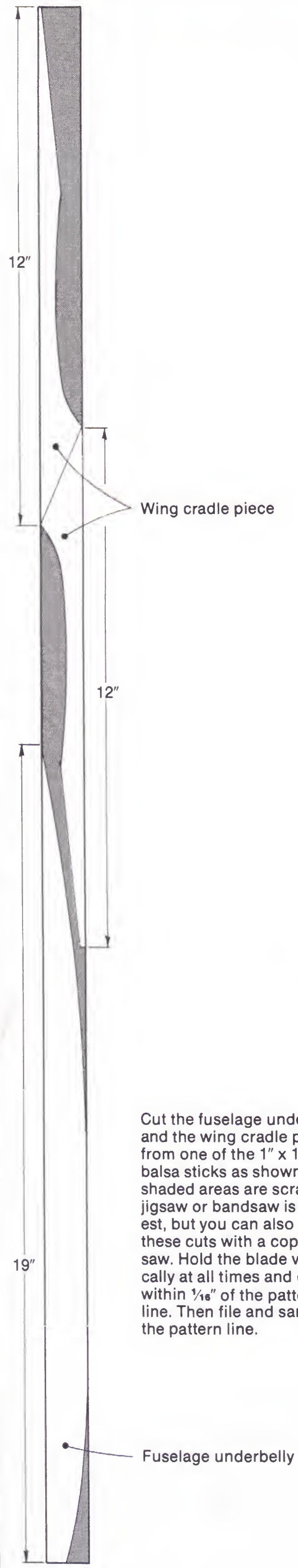
Major items needed for the Sunday Flier. The white rectangles (with a piece of ⅛" music wire laid on top of the lower two) are precut plastic foam wing panels from Ace R/C. Each panel is 5½" x 17" and its ends are cut to the correct dihedral angle. The wings require four panels, the horizontal stabilizer one panel, leaving one spare.



I often prepare all or most parts for a major assembly such as the fuselage before gluing anything, in effect making my own kit. The vertical stabilizer shown here is one I cut from an Ace wing panel and used on an early Sunday Flier. I recommend that you make the fin from ⅛" sheet balsa instead because balsa is much lighter.

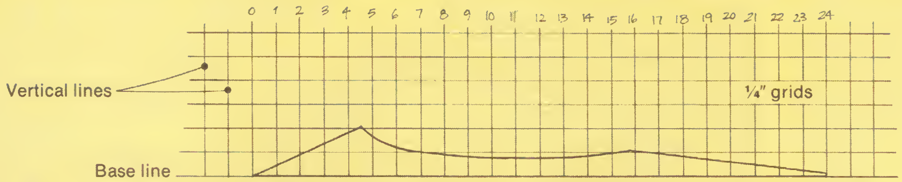


The wing cradle with the hardwood dowels epoxied in place. On several of the prototypes I later painted a windshield and windows onto the cradle. You can also represent these features with pieces of Trim Monokote or simply leave this area undecorated.

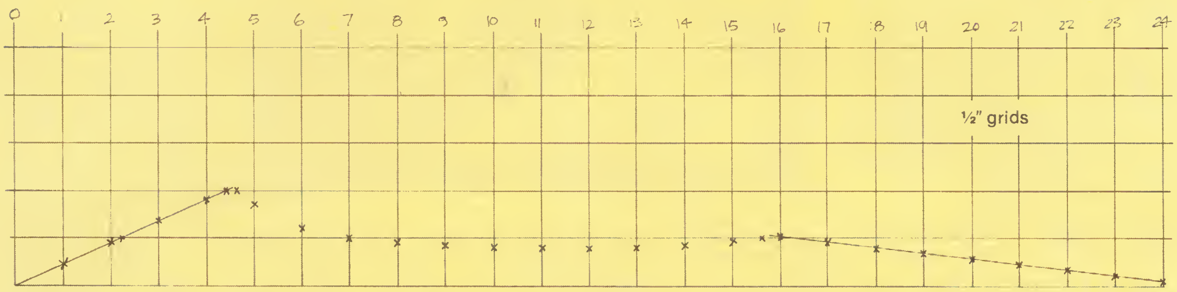


Cut the fuselage underbelly and the wing cradle pieces from one of the 1" x 1" x 36" balsa sticks as shown. The shaded areas are scrap. A jigsaw or bandsaw is fastest, but you can also make these cuts with a coping saw. Hold the blade vertically at all times and cut to within 1/16" of the pattern line. Then file and sand to the pattern line.

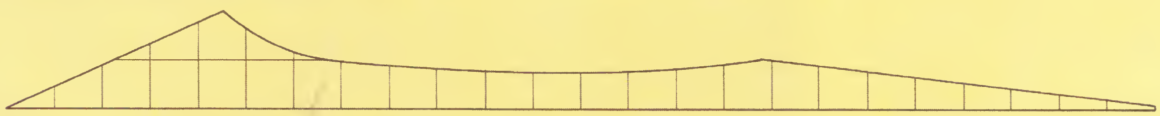
CUTTING OUT THE UNDERBELLY AND CRADLE PIECES



1. Trace the reduced-size pattern onto ¼" graph paper or draw ¼" grids on plain paper.



2. Obtain ½" graph paper or draw ½" grids on plain paper. Measure the distance on each vertical line from the base line to the pattern line on the ¼" sheet, double each dimension, and indicate it by an X on the corresponding vertical line on the ½" sheet.



3. Cut out the full-size pattern from the ½" sheet. Use directly or transfer to thicker stock.

ENLARGING PLANS

If full-size plans are available for a project, you'll almost always save time and money by buying these directly from their publisher. The next best method is to have reduced-size plans photomechanically enlarged, usually by a photostat or blueprint shop (look in the Yellow Pages under Blueprinting).

If you decide to enlarge the plans by hand, the following method works well — I'll use the wing cradle for the Sunday Flier as an example. The wing cradle drawing on page 18 states that it is ½ actual size. Trace the outline of the wing cradle onto a sheet of graph paper with ¼" grids, or just draw ¼" grids on plain paper. Next, find a piece of graph paper with ½" grids or draw ½" grids on plain paper. Number the grids on both sheets as shown.

Measure where the pattern crosses the leftmost vertical line 1 on the sheet with ¼" grids — in our example this is .1" and twice .1" is .2". On the sheet with ½" grids, make an X .2" up from the base line on the leftmost vertical line 1. Repeat this process for all remaining points. Now connect the intersections of the Xs, using a straightedge and French curves to join the points, or work freehand.

You've now created a full-size pattern for the wing cradle pieces. At this point you may cut out the pattern, place it onto the wood, and draw a pencil line around its edges. Alternatively, you may decide to transfer the pattern to a thicker piece of paper or cardboard like that used for file cards, creating a template that can be used many times.

The entire process is most accurate if you use an electronic calculator and a rule that is graduated in tenths and hundredths of an inch or go metric. In many cases, though, you can simply eyeball the measurements, and, in practice, you'll seldom have to mark all of the intersections individually— in the case of the wing cradle, you can trace along the bottom airfoil of a plastic wing panel to achieve the correct curve on the pattern.

edge razor blade or an X-acto knife, cut the sheet to the shape shown on the plans. When cutting the curved base of the vertical stabilizer, be certain to hold the blade at right angles to the sheet so that the fin will rest vertically on the horizontal stabilizer. Also, cut this bottom curve as accurately as you can so that it will be flush with the top surface of the horizontal stabilizer.

Round the fin's leading and trailing edges with sandpaper and sand the top curve into a pleasing rounded shape when viewed from the front.

Draw a center line on the horizontal stabilizer with a pencil, then epoxy the fin to the stab along this line. Sight along the center line from the front and make sure the fin is perpendicular to the stab.

To mount the engine, simply screw the backplate onto the hardwood pieces, using two ½" wood screws. Tilt the backplate at a slight angle, so that the screws go into the hardwood side mounting pieces. The angle can be either way, and if the holes are stripped in a bad landing you can remount the engine at the other angle.

Preparing the nose landing gear may be the most difficult step in building the Sunday Flier because the ⅛" steel wire is hard to bend. A vise and hammer are your primary metal bending tools. Put the wire in the vise with the bend point flush with the top of the vise jaws, then hit it repeatedly with a hammer just above the bend point, gradually forcing it to the desired shape. Yes, this will take the temper out of the wire but it will still be more than strong enough.

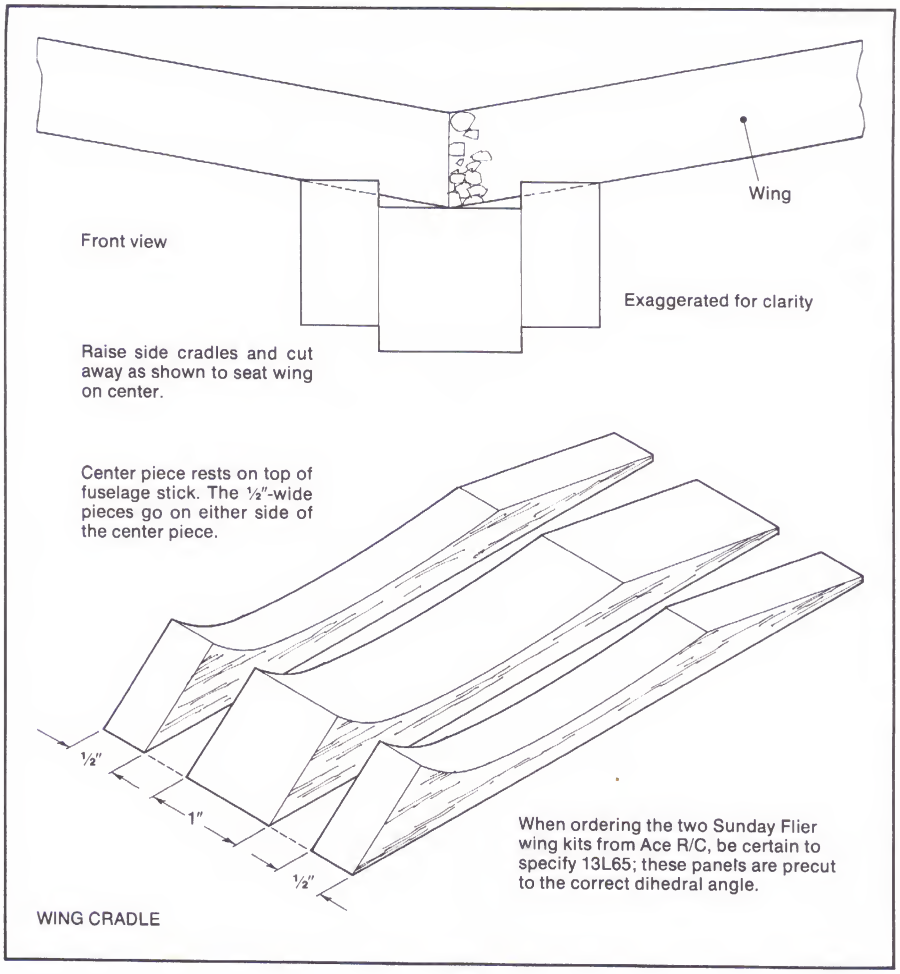
After you have bent the wire to the outline shown on the plans, bend the wire by hand until it lies flat upon your workbench.

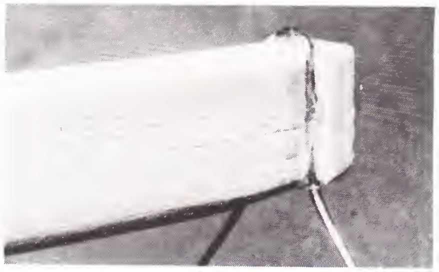
Slip the wire over the fuselage just aft of the hardwood engine mount pieces; it should wedge itself against the sides. Epoxy the wire in place and bind it securely with thread or fishing line wrapped several times around the wire and fuselage before the glue dries.

The size of the wheels isn't critical. The plans show 2" wheels because these are about the right size to help balance the model. Hold the wheels in place with collars or with short pieces of tubing slipped over the wire and held in place with a drop of instant glue. Collars are best because they allow you to change wheels more easily.

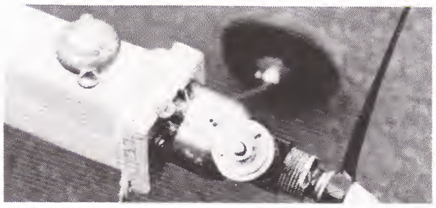
The tail skid is a 4" piece of 1/16" wire. Force the wire through the center of the fuselage stick at the angle shown on the plans. Bend the top 1" flush with the top of the fuselage and glue it in place. Bend the bottom end slightly.

Use a polyurethane-base paint if you

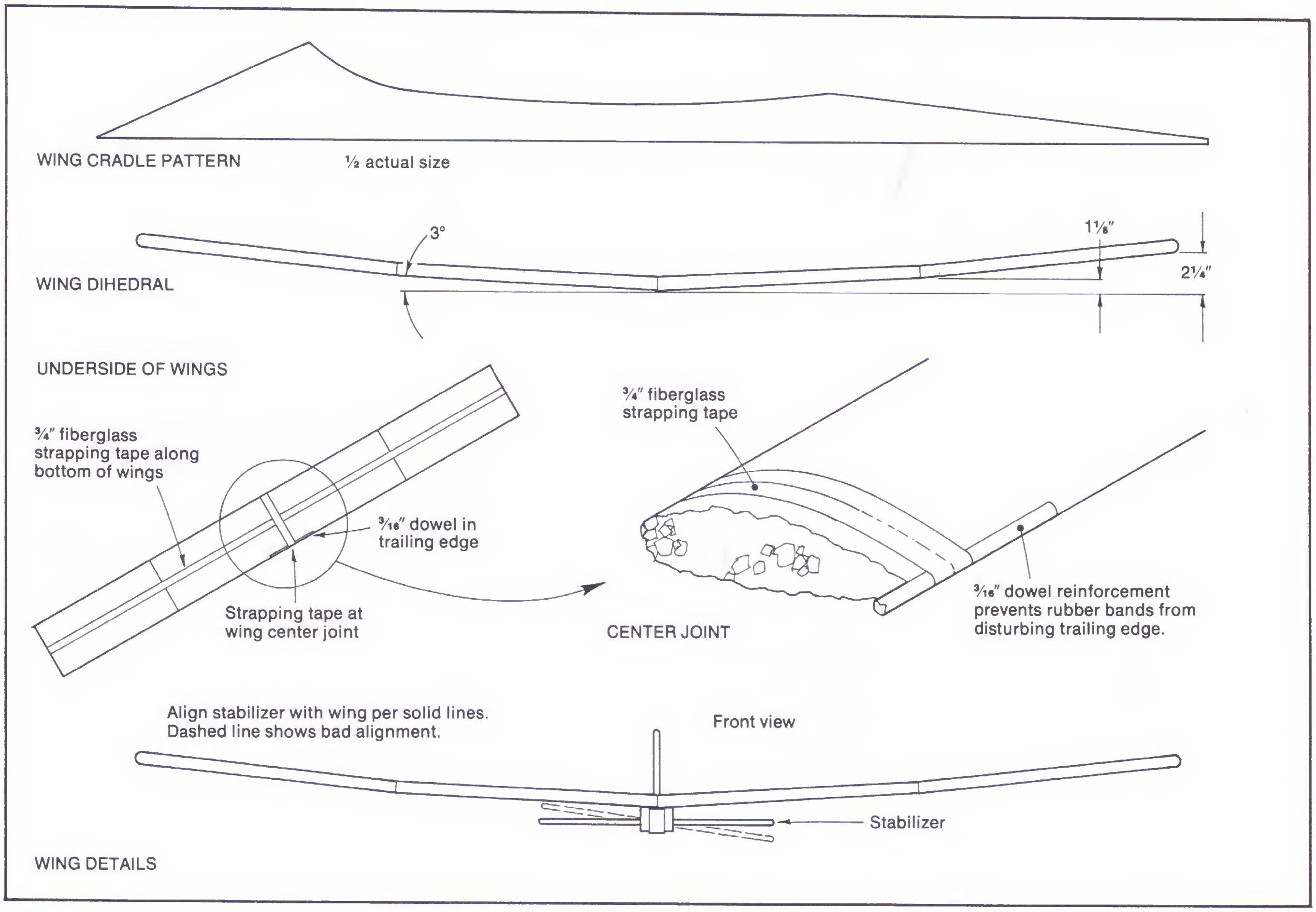


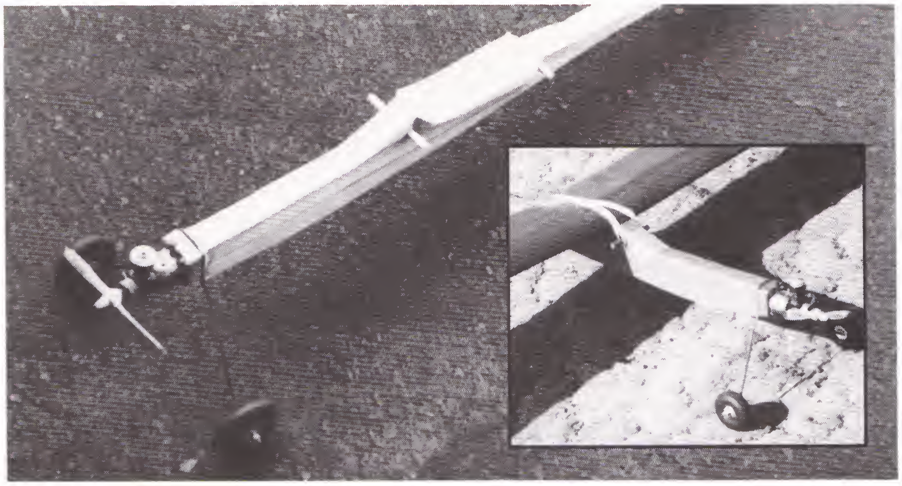


The ⅛" music wire main landing gear slides in place at the nose behind the hardwood engine mounting blocks. Use lots of epoxy glue and bind the wire to the fuselage with carpet thread or fishing line before the epoxy hardens.



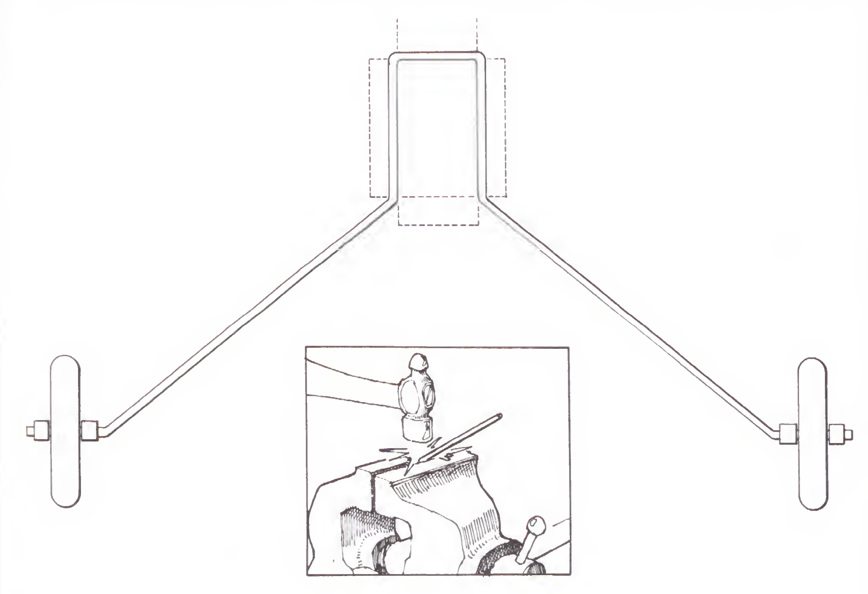
Three important points to observe when preparing the engine mount. First, trim the end of the balsa fuselage stick and the two hardwood blocks so that the engine will be held with about 3 degrees down thrust for increased stability in powered flight. Second, the ½" wood screws must go into the hardwood on either side of the balsa stick (not into the balsa). Third, fuelproof the wood by smearing a light coat of 5-minute epoxy over the engine mount.





The Sunday Flier performs best with a 5 x 3 or 6 x 3 wood or nylon propeller; 2"- to 2½"-diameter wheels (wood, plastic, or rubber) look right and help balance the model. (Inset) The wing hold-down rubber bands form an X as they cross over the wing center section. For safety's sake, change the rubber bands frequently — before they become frayed.

A freshly painted Sunday Flier glistens in the sunshine before its first flights.



MAIN LANDING GEAR WIRE

Bill of Materials

- Two 1" x 1" x 36" balsa sticks
- Two Sunday Flier wing kits
- Two pieces of hardwood approximately ¼" x ½" x 1½"
- 12" of 3/16" dowel
- Two ½" wood screws
- 84" of ¾" fiberglass strapping tape
- Several No. 64 rubber bands
- Two 2"- or 2½"-diameter wheels and four ⅛" wheel collars
- Approximately 16" of ⅛" music wire for the nose landing gear and approximately 4" of 1/16" music wire for the tail skid

want to paint the wings and horizontal stabilizer because other types of paint may dissolve the foam plastic.

You can use one of the iron-on plastic covering films instead of paint; if so, be sure to choose one that needs only moderate heat, such as Top Flite Ekonokote, or you will melt the foam.

The fuselage must be protected from fuel and exhaust — use an epoxy, butyrate dope, or any other fuel-proof paint.

Drill 3/16" holes in the fuselage at the points shown on the plans, insert the dowels, and glue them in.

Carve and sand the cradle until the wings rest securely without wobbling. Also carve and sand the side cradle pieces so that they are attractively streamlined when seen from above. Attach the wings with rubber bands.

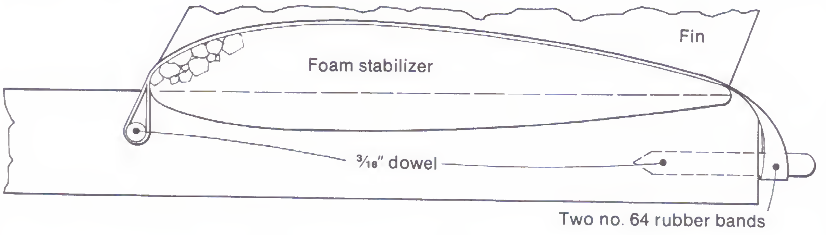
Attach the tail assembly with rubber bands going from the dowel in front of the stab and looping over the dowel which sticks out the rear of the fuselage. Be sure the vertical fin is lined up at right angles with the fuselage. Also, sight down the fuselage from the nose and check the alignment of the stab with the wing — the stab must be level.

Adjusting the Sunday Flier. Before flying, hold the plane at its balance point. The model should hang horizontally. If it hangs with the nose down, add small weights to the tail until the model is level, then tape or glue the weights in place. Similarly, if the tail hangs down, add weights to the nose.

Now test glide the model. Launch straight ahead — not up — at about the same speed as you would toss a softball to a friend some 20 feet away.

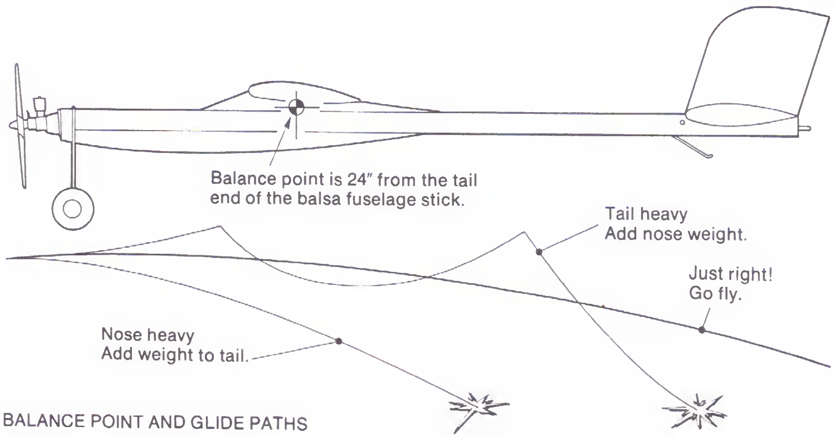
The model should go straight ahead and gradually nose down into a gentle glide. If it noses up, then drops sharply to the ground, add more weight to the nose until the nosing-up tendency disappears. If, on the other hand, the model leaves your hand and dives steeply, remove weight from the nose or add weight at the tail until the model glides gently forward.

When the model glides properly, it's time for the first powered flights on reduced engine power. There are two

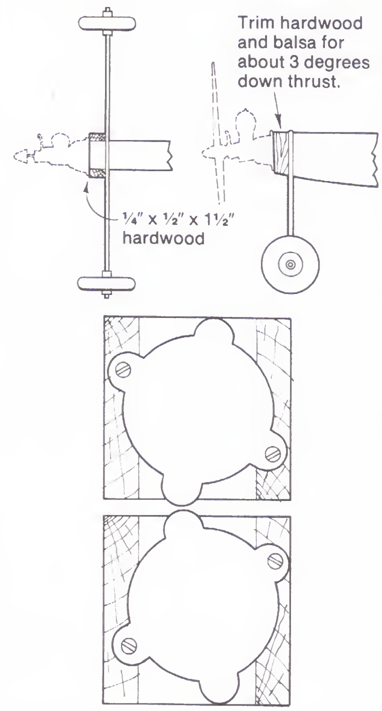


Saw, carve, and sand the fuselage stick to form a cradle for the horizontal stabilizer. Note that the center line of the stabilizer's airfoil (dashed line) is parallel to the top of the fuselage stick.

CRADLE CUTOUT FOR THE HORIZONTAL STABILIZER



BALANCE POINT AND GLIDE PATHS



Mount the engine at an angle, using a 1/2" wood screw through one lug on each side of the engine's backplate into the hardwood. If these screws work loose or a lug breaks, tilt the engine in the other direction.

ENGINE MOUNT

Always launch the Sunday Flier with its nose level or pointing down a few degrees.

ways to keep the power down during test flights. One is to run the engine rich. The other is to reverse the propeller; this lets the engine run fast (.049s operate most reliably at close to top speed) but the prop creates less thrust.

Launch the Sunday Flier just as you did in the glide tests. It should move out in a gentle circle to the left, climbing slowly. When the engine stops, it should glide either straight ahead or in a gentle right or left turn. A gentle turn in either direction is best because the plane won't glide as far away.

If the model, upon launch, goes into a swooping flight ending in a mild crash, carefully shift the tail assembly, moving the left side of the stab forward a little and the right side aft. Shifting the tail assembly in this way gives a slight left rudder action.

Launch the model again at low power. This time it should leave your hand and climb gently to the left as it is supposed to. If you have shifted the stab too much, the model will circle to the left and spiral to the ground. If it does that, set the stab at about half the offset you put in earlier.

Full-power flights. You are now ready for full power. Limit the engine run to 15 seconds for the first few flights. The Sunday Flier is not a hot rock performer and it isn't meant to be. It flies in a steady, gentle turn at a fairly slow speed, climbing to several hundred feet. After you have observed the rate of climb, you can make longer flights with engine runs up to about 30 seconds, but watch out — if the model gets too high, it may enter a rising current of air, a thermal, and you'll have a long chase. Don't fly in winds of more than five miles per hour and don't forget to put your name and address on the model, just in case it flies away.

The Sunday Flier is easy to repair. The wood parts can be glued back to their original shape with 5-minute epoxy or one of the instant glues. If any of the foam surfaces break, smear 5-minute epoxy into the joints and reassemble the parts. You may want to lay a piece of thin cloth over the joint before the epoxy dries, smearing the glue into the cloth, saturating it. The repaired part may not be as pretty as before but it will be strong.

Project 4

The Rotoriser

Up to this point, if you decided to build the projects in this book in the order in which they are presented, you have a flying rag, a flying bleach bottle, and a simple foam-winged airplane. Doesn't sound like much when you put it that way, I know, but unless I miss my guess, you've had a lot of fun without a lot of work. Also, I'll bet, part of the fun was taking your unorthodox flying machines out of their boxes and carrying them to the launch point, only to hear the spectators giggle and say "You really gonna try to fly that thing?" You then watched them as they observed the machine going skyward. "I never would have believed it if I didn't see it," is the most common reaction.

Grasp the Rotoriser firmly by its motor arm when servicing or starting the engine.

The same will happen with the Rotoriser, except that as the machine floats slowly back to the ground, the reaction by onlookers is even more pronounced. Usually it is "Hey, fly it again will ya?"

The Rotoriser is a free flight fun machine, a single-rotor helicopter. It won't win any contests — unless there is one for "most unusual design" — nor will it set any records, but you'll have more fun with it than with many other flying machines, simply because it is easy to build, launch, and fly. By varying the trim tab on the stabilizer you can get a wide variety of flight patterns.

The concept of the Rotoriser was originally developed by Charles W. McCutchen in 1954. Various designs have been published over the years, principally in European magazines. The one which appears here, with minor changes I have made, was developed by Brian Bush, a young man who lives in Florida.

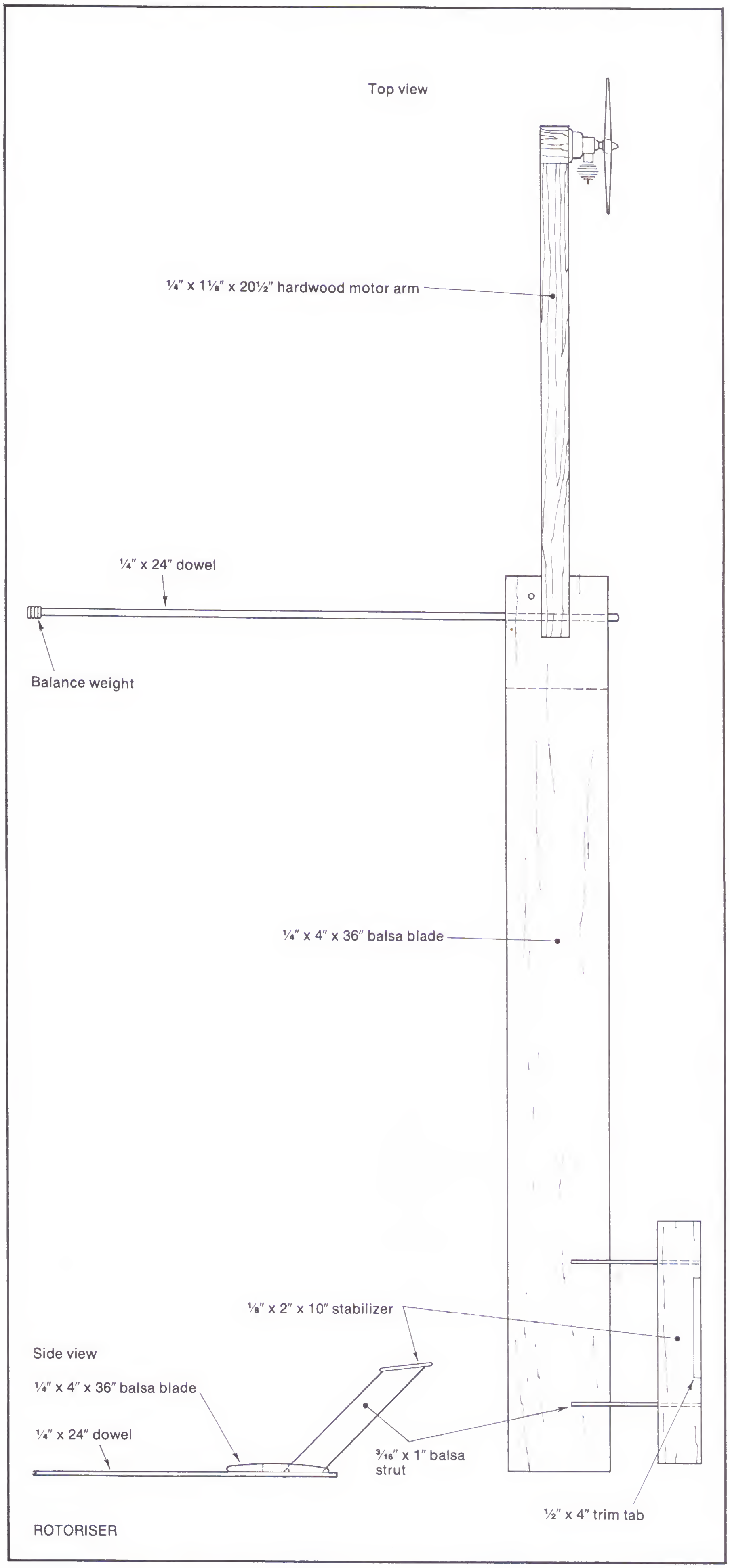
The design is generally called the McCutchen Machine after its inventor. However, I chose the name Rotoriser because as it rotates, it rises. That is, of course, if the engine is running in the right direction. If you happen to get the engine going backwards and try to launch the machine, you'll soon discover that it's a Rotorooter.

The Rotoriser is so simple that you can build it in one evening and fly it the next day. The Bill of Materials lists everything you'll need.

Construction. Make the main rotor blade from the 1/4" x 4" x 36" piece of balsa, shaping the sheet into a flat-bottomed airfoil.

Cut a 2½"-long, 1⅛"-wide slot in the center section of the main blade as shown on the plans. Insert one end of the hardwood motor arm — the piece that's 20½" long, 1/4" thick, and 1⅛" wide — into the slot on the main blade and glue it in place.

Reinforce this center section joint with a 4" x 4½" piece of 1/16" plywood glued to the bottom. Wrap fiberglass



cloth around the joint and saturate the cloth with 5-minute epoxy for yet more strength. This section of the Rotoriser must be strong because the machine may land tip first, which puts quite a strain on the center joint.

The photos show a more complicated metal mount I used on the prototype, but a wooden mount is easier to make and works just as well. Just glue the two ½" x 1⅛" x 1½" wood blocks on the end of the arm, one on top and one below, with their edges flush with the edge of the motor arm. Then, for appearances' sake, shape them to the contour shown on the plans.

Now it's time to put the stabilizer assembly together at the end of the main rotor blade. Check over the plans carefully and cut slots at the locations shown. These slots should be just wide and long enough so the struts that support the stabilizer slide tightly into them. Cut the struts from the ³⁄₁₆" x 1" balsa stock, slide them into the slots at the angle shown, and glue them firmly in place.

Trim the top of the stabilizer struts at an angle of six degrees or so to the flat bottom of the rotor blade. The trailing edge of the stabilizer will be raised about ¼" from the leading edge to achieve this angle. It is not critical, since adjustments to the trim tab can compensate for minor variations in the angle.

Before gluing the stabilizer onto the struts, make the trim tab. Mark the outline of the trim tab on the stab and cut it out with a single-edge razor blade or an X-acto knife. Sand the edges of the trim tab and the edges of the opening where the tab will fit to provide clearance so that the tab can be adjusted easily to various settings.

Attach the trim tab to the stab with soft wire hinges: Pipe cleaner wire is excellent because the fuzzy tufts attached to the wire make good surfaces for gluing the wire to the wood. Cut the wire into two lengths of about 1" each, glue the pieces to the tab so that about ½" sticks forward, then glue those ends to the stab surface. Be sure the tab is centered in the opening so it will move easily when you bend the wire for different settings.

Glue the stab and trim tab assembly to the top of the struts.

You must now fuel-proof all wooden parts with clear or colored model airplane dope such as Pactra Aero Gloss or Sig Supercoat — the extra weight of colored dope is insignificant, so use it if you prefer.

The balance arm is a 24" piece of ¼" dowel with a lead or modeling clay weight on the outer end. The inner end is held to the rotor blade with rubber bands. The rubber bands make it easy to remove and store the arm alongside the rotor blade for transport; they also absorb the shock of hard landings.

Mount the engine to the motor arm with four ½" wood screws through the holes in the backplate of the engine and into the hardwood mounting blocks.

With the engine mounted and the balance arm attached to the rotor blade, drill a hole in the center of the rotor arm at the location shown on the plans. With this as a balance point, add weight — strip lead, solder, or modeling clay — to the end of the balance arm until the whole assembly balances. You might also have to add ballast at the end of the rotor blade or the motor arm, depending on the grade of balsa and the amount of dope you used.

Launch pad. Your Rotoriser is ready to fly once you've made a launch pad. Cut a three-foot piece of broomstick or garden stake and tape a nail to one end with the sharp end of the nail sticking up. Blunt the end of the nail so you don't stab yourself. Carve the other end of the stick to a point so you can push it six to eight inches into soft earth.

Solder a washer about an inch from the end of the nail, level with the end of the stick. You may prefer a wheel collar instead of the washer. The washer or collar serves as a bearing for the Rotoriser before it lifts off.

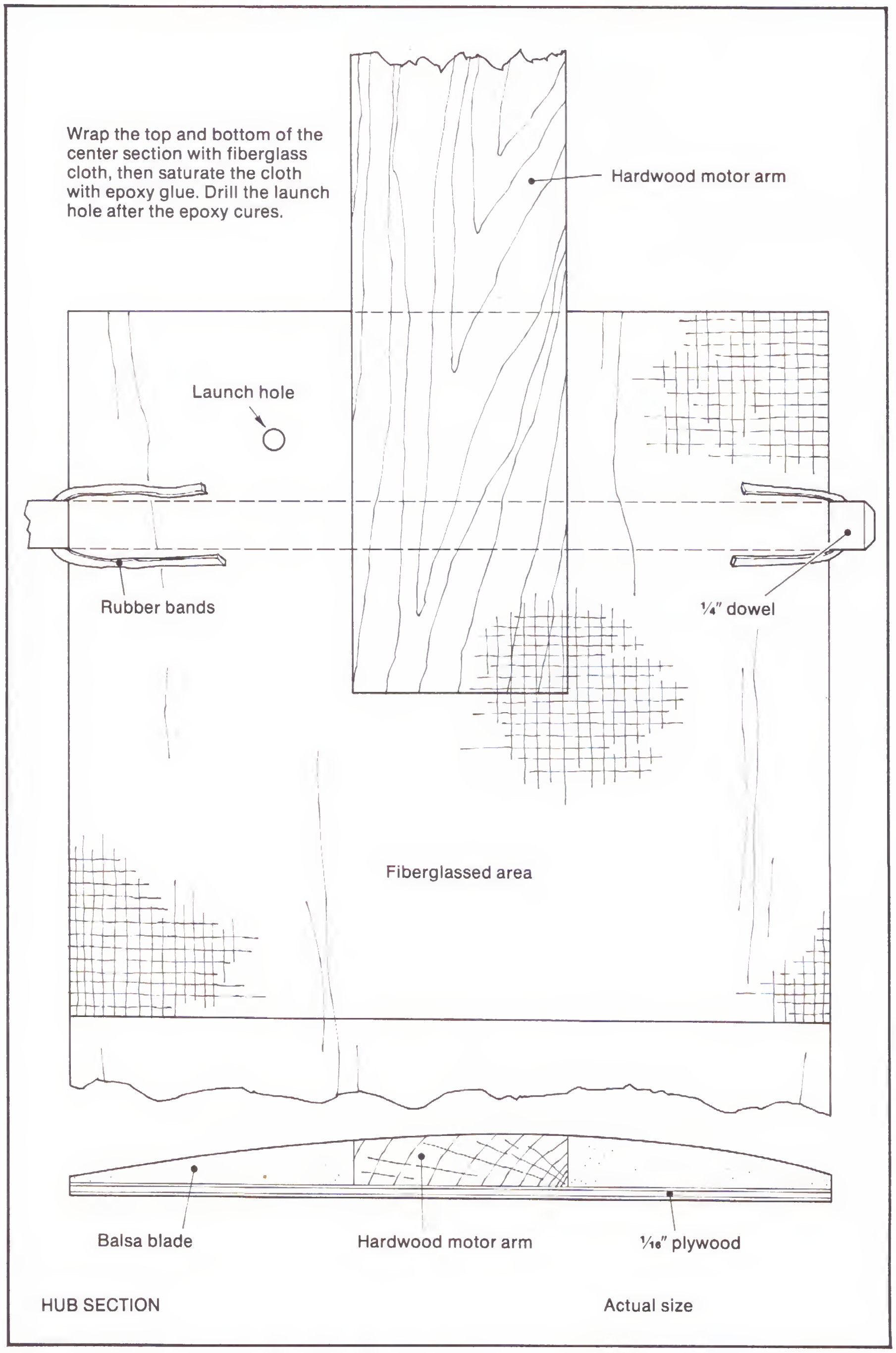
Flying the Rotoriser. With the Rotoriser and launch pad completed, it's time for some test flights. Select an open area, preferably a large field covered with grass or low weeds. Pick a day when there is little or no wind — there's no sense in losing the machine on its first flight.

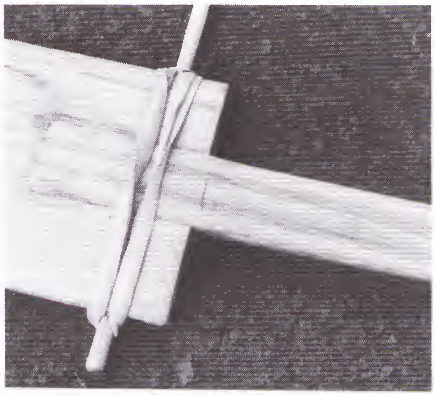
Push the end of the launch pad stick into the ground far enough so that it is steady when you place the Rotoriser on the nail. Check its balance by rotating the machine by hand.

Start the engine, let it run about 30 seconds, then set the Rotoriser on the launcher with the nail sticking through the hole in the center section. Hold the machine level by the end of the rotor blade ahead of the stabilizer, then let go. The Rotoriser will begin to turn, gain speed, and lift off. Watch it carefully, because it may be slightly out of balance and sway towards you. Get out of the way and let it continue — it will soon stabilize, climb until the engine stops, and then autorotate down.

The rate of climb will be determined by the angle of the stabilizer and the setting of the trim tab. For the first flights, set the trim tab even with the stabilizer to give a fairly fast climb. However, the climb may be too fast and the Rotoriser may get so high that it will oscillate as well as autorotate when the engine quits, leading to a ragged descent and a hard landing.

If the Rotoriser oscillates while descending, bend the trim tab down a little and make another test flight. Bending the tab down reduces the angle at which the main rotor hits the air — the angle of attack. The rotor then pro-

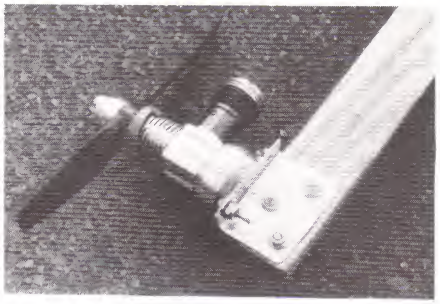




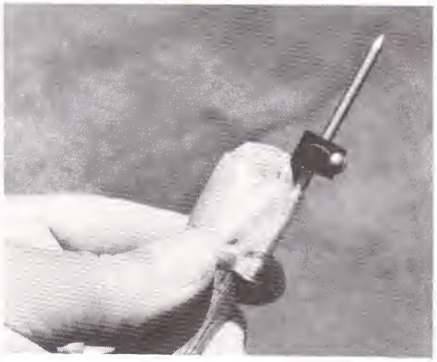
The reinforcing epoxy-soaked fiberglass cloth at the hub is nearly invisible yet greatly strengthens this critical area. I'll next drill a small hole near the base of the hub for the launch pad nail.

Bill of Materials

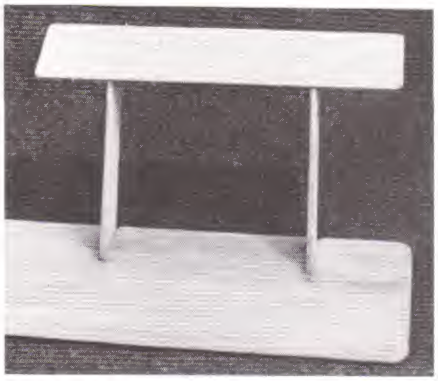
- A ¼" x 4" x 36" sheet of medium-hard balsa
- A ¼" x 1⅛" x 20½" piece of basswood, spruce, or pine
- A 24" piece of ¼" dowel
- A 2" x 10" piece of ⅛" medium-hard sheet balsa
- A 1" x 12" piece of 3⁄16" medium-hard sheet balsa
- A 1⁄16" x 4" x 4½" piece of plywood
- Two pieces of ½" x 1⅛" x 1½" of basswood, spruce, or pine
- Four ½" wood screws
- A 4½" x 9" piece of fiberglass cloth
- A 36" piece of broomstick or garden stake
- A 3" nail
- A wheel collar to fit the nail or a washer to solder to the nail



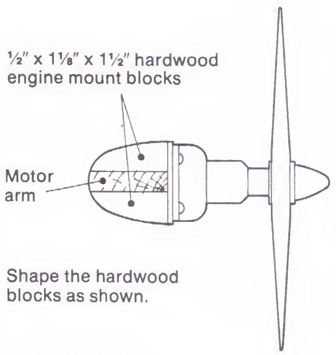
A scratchbuilt metal motor mount works well, but a mount made of hardwood blocks glued to the motor arm is just as good and a lot easier to construct.



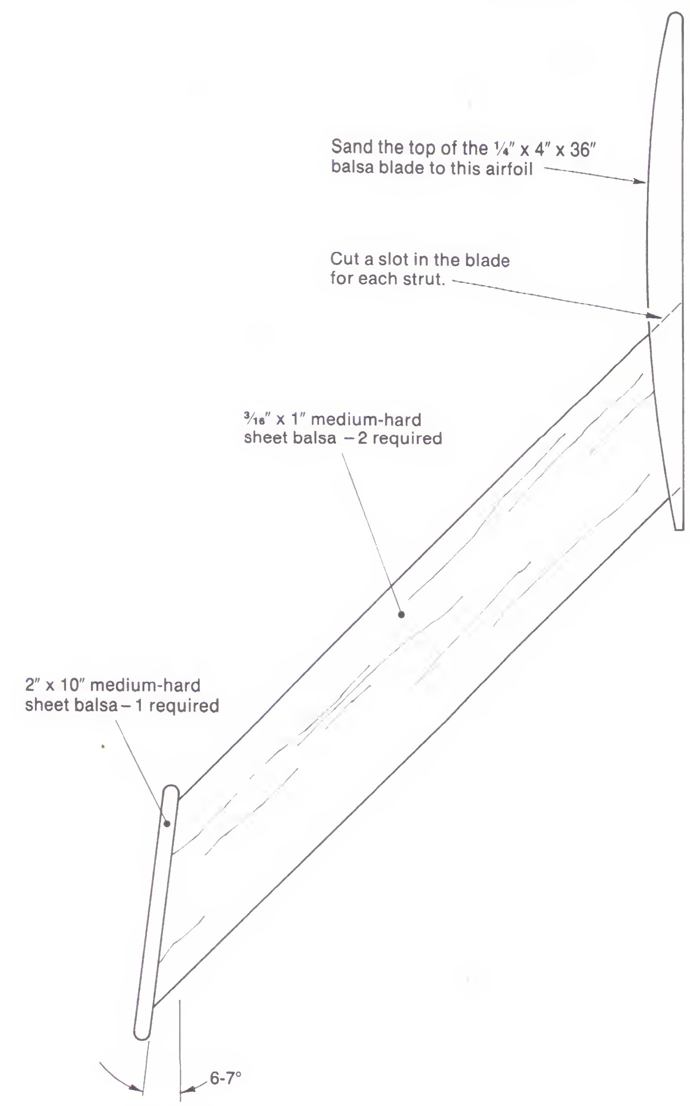
The launch pad nail should be slightly smaller in diameter than the hole in the rotor blade. Tape the nail to the broomstick, install a wheel collar or solder on a washer, and blunt the end of the nail.



The struts and stabilizer before cutting out and hinging the trim tab.



ENGINE MOUNT



STRUT PATTERN AND BLADE AIRFOIL

The first miniature single-rotor helicopters flew more than 30 years ago; each new generation of model aviators is fascinated by the concept.

The only thing predictable about the Rotoriser's flight path is that it will rotate clockwise as long as the engine is running. Adjust the trim tab and vary the amount of balance weight until you're pleased with the machine's performance.

duces less lift. You'll also need to experiment with needle valve settings because the fuel flow changes a little due to centrifugal force when the Rotoriser starts rotating. With a bit of experience you can set up the machine so that it will spin slowly up to about ten feet, wander around at that height until the engine stops, and then settle slowly to earth. At the other extreme, you can trim the machine so that it will virtually disappear overhead.

If you can't push the launcher stick into the ground, there are two ways (both chancy) to launch the Rotoriser by hand.

One is to hold it at the center section with the engine running, and throw it straight up with a twisting, clockwise action. Then get out from under fast!

The other method is a little less dangerous, although you still have to be alert. With the engine running, hold the Rotoriser by the end of the rotor blade opposite the engine, and toss it into the air with a spinning action in the same way that you toss a Frisbee. Toss the Rotoriser as level as you can or it will circle out and return like a boomerang.

Obviously, it's best to use the launch pad.

When the Rotoriser is in powered flight, the noise is a sort of whomp, whomp, whomp as the blade rotates. It will draw kids as a light draws moths. It's a real fun machine both for you and your spectators. Kids love it. At least, kids like you and me.

Project 5
Spindizzies

This book's objective is to provide projects you can assemble with a minimum of work and expense for a maximum of fun. With that in mind, I came up with two utterly ridiculous machines I call the Spindizzies. When I first showed the prototypes to friends, their reaction was something like "Hey, those things have no redeeming social value!" But I disagreed. "Maybe not," I replied, "but they sure do entertain the kids."

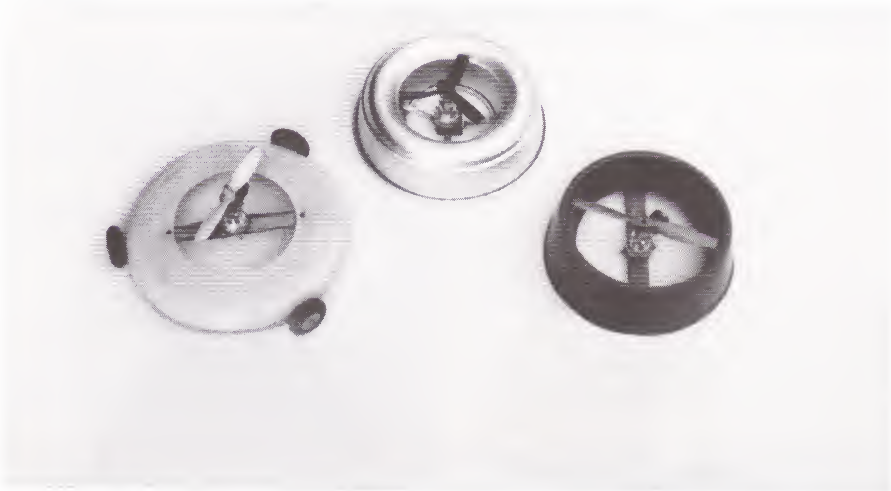
So I've included them here. I think you will agree that they are amusing. True, a Spindizzy doesn't fly, roll, or float. It just spins around crazily and scuttles from place to place, occasionally rising off the ground a few inches, only to tip one way or another. When an edge hits the ground, it bounces off in another direction.

The basic principle behind these machines is a well-known law of physics: "For every action there is an equal and opposite reaction." The propeller's rotation causes the unit to which it is attached to try to rotate in the opposite direction. If the machine is heavy, it won't move; if it is light, it will. So, if the propeller is turning horizontally in a counterclockwise direction (as viewed from above), the machine wants to rotate clockwise.

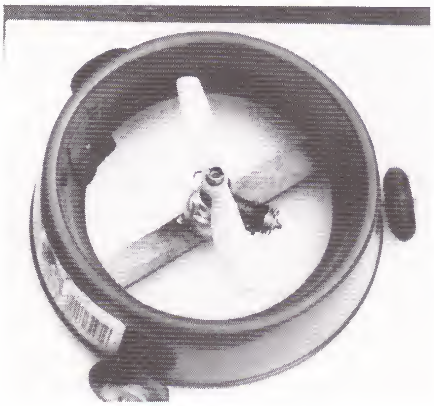
The other principle is aerodynamic; it is called "ground effect." The propeller forces air towards the ground. When the blast of air hits the ground, it has to go somewhere, so it flares out horizontally. Here's where ground effect comes into the picture. House the propeller in some kind of tunnel and it will force air down to the bottom of that tunnel. If you match the thrust of the blast of air to the weight of the tunnel and power plant (the vehicle), the vehicle will rise just high enough to let the air escape.

The Spindizzies are rugged, so you won't have to spend a lot of time on repairs. In fact, the most time you will spend, once you've built these jobs, is taking the engine out, removing the tank, and cleaning the reed valve. This is particularly true if you are operating from a dusty surface. These little gadgets move a lot of air and if the surface is dirty some of that dirt will get into the air intake, clog the reed valve, and you'll have to clean it. So, try to operate from a relatively clean surface. The best surface would be something like a golf green, but I don't think the greenkeeper would approve. Don't use a golf course green — just something like it. Astroturf would be fine.

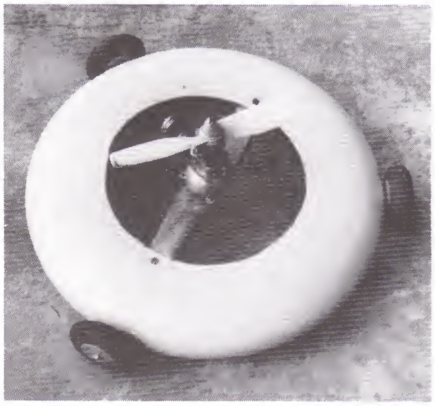
I tested several types of Spindizzies during development. Some just sat there noisily until the engine stopped. Others took off in wild gyrations and crashed. I dropped those types from the program. I've included the two which made the most amusing movements with the least danger to spectators.



Here are three prototype Spindizzies. The Spindizzy Dog Dish at right performed well after I added ¾"-diameter wheels; the Cakewalker at top never calmed down, so I discarded it; the Spindizzy Frisbee with wheels was an instant success.



Next to the Fantastic Ragtime Flying Machine, the Spindizzies are the simplest projects in this book. You can prepare a Spindizzy in less than an hour.



The Spindizzy Frisbee is even easier than the dog dish version because the plastic is thinner and only two wood screws are required to hold the motor mounting bar.

Spindizzy Dog Dish. Let's start with the Spindizzy Dog Dish. Sergeant's is one of the best-known manufacturers of dog food. The firm also makes several plastic dog dishes; I used No. 3227. The diameter of the base is 8", the slanted sides are 2¾" high, the diameter at the top is 6¾", and the inside depth is about 2¼".

In addition to the dog dish, you'll need an engine mount. The mount is a bar of wood — basswood, spruce, maple, pine, or whatever you have lying around — ¼" thick, ¾" wide, and 7⅝" long. Attach the mounting bar to the dog dish with a couple of leaf hinges, which can be the metal type used on small boxes or the plastic type used on

flying model airplane control surfaces.

First, though, remove the bottom of the dog dish so that air can flow down through the dish when the propeller is turning. Here's a simple way. Cut a disk 5½″ in diameter from a piece of scrap cardboard. Insert this disk in the dog dish, centered as accurately as possible so that it is level when the dish rests on your work table. Using a felt-tip pen, scribe a circle on the dog dish around the circumference of the cardboard disk. Next cut out the bottom of the dog dish. One way to do this is to work slowly around the circle with a very sharp knife. Another way is to drill a series of holes, about ⅛″ in diameter, around the circle at ¼″ intervals and then cut away the plastic between the holes. After you have removed the bottom, sand the cut edge smooth so it won't scratch your fingers.

Install the engine mount by attaching one leaf of a hinge to one end of the wood bar, using wood screws. Similarly, attach the other leaf of the hinge to the edge of the dog dish, using machine screws and nuts. Be certain that the top of the mount is level with the plane of the bottom opening — this will ensure that the engine's thrust line is pointing straight down when the machine is on a level surface.

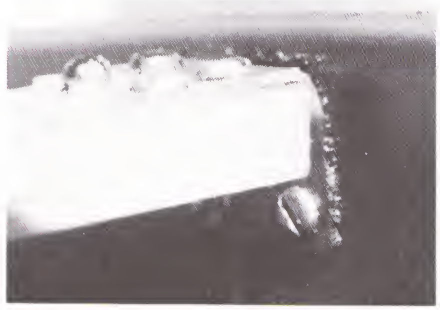
Before attaching the other end of the engine mount to the dog dish, mark a spot at the center of the bar, then place the engine's backplate on the bar so that it is centered on the mark. Place the backplate on the bar at an angle so that two of the diagonally opposed mounting lugs are located about ¼″ in from the edge of the mounting bar. Mark their location by pushing a pencil point through the mounting lug holes.

Don't mount the engine yet. First attach the other end of the mounting bar to the dog dish. As with the first end, again make sure that the center mark on the bar is centered in the opening. Move the bar slightly to the right or left to achieve this. When all is well, attach the second hinge to the dog dish.

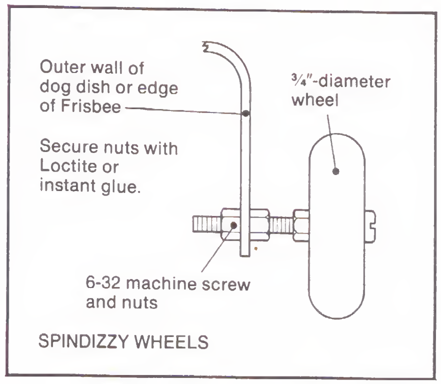
Mount the engine using ½″ wood screws through only two of the mounting lugs. Set the lugs at an angle as I just described — this way it will be easy to attach the glow head clip when starting the engine and the needle valve will be off to one side of the mounting bar.

Your Spindizzy Dog Dish is almost finished. In fact, I tried to run it this way and it worked but every now and then the engine would speed up too much and the Spindizzy would rise too far off the ground and flip over. So I refined the design by adding three wheels spaced equally around the outside wall of the dog dish. Drill three 1/16″ holes in the plastic and mount each wheel on a 1″-long 6-32 machine screw. Make sure that the wheels rotate freely.

Your Spindizzy Dog Dish is ready to



On the Spindizzy Dog Dish I used nylon model airplane hinges, wood screws, and 6-32 machine screws and nuts to attach the wood motor mounting bar to the plastic sides of the dog dish.



run. Hold it by the engine mounting bar when starting the engine. Adjust the needle valve for steady running, set the machine on its wheels, and let go. It will immediately start to rotate, going faster and faster. Then it will lift crazily off the ground, with first one wheel still touching, then another. If the ground is absolutely level — an unusual condition — the machine will not wander far. But, and this is what usually happens, if the ground is even slightly unlevel, the Spindizzy Dog Dish will take off in whatever direction the ground slopes. If the slope varies, the machine will change direction.

You can also make it change direction by letting one of the wheels hit the side of your shoe, but there's no way you can tell which direction it will bounce, so be cautious.

It's fun to see the machine slide toward the curb — if you are running in an empty street it will hit the curb, bounce off, slide back, and, if there are any leaves on the street, blow them every which way. Then, when the engine quits, you'll probably have to clean the reed valve, which takes five to ten minutes. Remember the warning I gave in the first chapter — don't let the retaining spring snap out of its housing and fly off into the air. The retainer is almost impossible to find on a grassy or asphalt surface.

I didn't mention the size of the wheels earlier because this may vary. I used ¾″-diameter wheels on the prototype, but you may want to try larger or smaller wheels. The larger the wheels, the more sedate the machine becomes. Smaller wheels place the rim of the dog dish closer to the ground, increasing the amount of ground effect, causing the machine to gyrate wildly. Experiment until you get the action you want.

Spindizzy Frisbee. The second Spindizzy design is similar to the first, but a bit wilder. It's the Spindizzy Frisbee.

As do dog dishes, Frisbees come in different sizes. I had an old, well-used, 9″ Frisbee and decided to experiment with it. It turned out to be easier to make into a Spindizzy than the dog dish. However, it is a little more expensive simply because Frisbees usually cost more than dog dishes.

Start by cutting a 5″-diameter hole in the center of the Frisbee. You'll find it cuts more easily than the dog dish.

Next attach the engine mounting bar to the Frisbee. The bar is ¼″ thick, ¾″ wide, and 6″ long. The tips will extend ½″ beyond the rim of the hole. Mount the bar with a couple of ½″ wood screws. As in the case of the Spindizzy dog dish, mark the center point of the bar, determine the location of the mounting lug holes, and mount the engine so the needle valve points off to one side of the mounting bar.

You must use wheels with the 9″ Frisbee because the spinning Frisbee creates so much lift that without the added weight of the wheels, it will take off and rise rapidly into the air. Then, because the weight of the engine is slightly off center, gyroscopic precession takes over, the Frisbee wobbles insanely, flips, and crashes.

I simply removed the wheels from the dog dish and installed them on the Frisbee. Here again the size and weight of the wheels will determine the degree of wildness with which the Spindizzy Frisbee scoots around. Mine weighs eight ounces with the wheels mounted and the engine installed, and moves very actively. Start with an assembly which weighs approximately the same; later, if you want to experiment, put on lighter wheels and see what happens. Not too light, though, or your Spindizzy Frisbee will rise and descend faster than you can get out of the way.

Project 6

The Puddle Jumper

For a change of pace let's build a machine that's equally at home on the ground and in the water, that can't fly away, and isn't likely to need major repairs.

The Puddle Jumper is just such a machine. It is manufactured as a kit (No. B-26) by Sterling Models, Inc. The hull and cabin are vacuum-formed plastic; other parts are balsa or plywood. The Puddle Jumper is 18½" long with a beam of 7½". You can buy the kit from a local hobby shop or order it by mail from Sterling, in which case be sure to mention in your letter that you don't have access to a hobby shop.

The kit instructions are clear and complete, though I'll mention a few places where you may want to deviate from them when assembling your model. As when building any kit, the first stage is to examine the parts, study the plans, and read the instructions from beginning to end. Then read the changes I've suggested here.

The kit plans show how to install a two-channel RC system. I'll show how to build the model so that you can operate it free-running or with a tether — you may add radio control later if you wish. The Puddle Jumper runs great on any flat surface — preferably concrete or blacktop. If you live on a lightly traveled dead-end street you can run the Puddle Jumper at the turnaround end. Just be sure to keep a sharp lookout for your neighbors' cars and delivery trucks.

Assembling the kit. After you've read the Introductory Note on the plans, break out all of the die-cut parts. This may be simple or a little troublesome. If you happen to buy one of the kits that was made when the dies were new, the cuts will be clean and the parts will break out from the sheet easily.

However, you may get a kit that was put together after the dies had become a little dull or the wood may be tougher than usual. In either case, you'll be able to get most of the parts to fall out by sanding the back of the die-cut sheet. If some stubborn parts remain, take a single-edge razor blade or an X-acto knife and cut carefully along the die-cut line. That will do the trick.

Sand the edges of all die-cut parts to remove slivers. Each die-cut part has a number printed on it, so you won't have trouble identifying the parts. Keep them in the kit box, though; some of the parts are small and can be hard to find if they fall on the floor.

Proceed with Step 1. Make sure that the parts are lined up with their edges flush when you glue them together.

I found that combining Steps 2 and 3 into one assembly sequence worked best. Lay a piece of waxed paper on a flat working surface. Then snap fit the keels, bulkheads, and wheel well sides (part 11) in place and insert the doublers 2-3 and 5-6 where shown on the plans. Place this assembly upside down on the waxed paper. Make sure all of the parts are properly located — that the bulkheads and keels are flat against the working surface and the hatch supports are up off the working surface just the right distance so the hatch will be flush with the deck when mounted. To do this, put the hatch on the working surface and fit the keel and bulkhead structure to it. This will ensure that the hatch fits and will also help to align the bulkheads without using a triangle or square.

When everything is properly aligned, tack glue the assembly with small drops of instant glue. Do not glue the hatch to the supports — just make sure it is snugly cradled.

Remove the tack-glued assembly from

The Puddle Jumper is a kit-built amphibious vehicle that is powered by an .049 turning a tractor propeller. The engine is easily accessible for starting and adjustments.

the working surface, turn it right side up, take out the hatch, and smear glue on all the joints. Any waterproof glue will work, though if you're in a hurry Hot Stuff Super T will seal the joints in just a few minutes. Then, to complete this part of the assembly, install the engine boom (No. 10).

Step 4 explains how to trim excess plastic from the edges of the hull. When doing so, don't trim the excess plastic flush with the hull sides, but leave about 1/8" protruding to serve as a support for a soft rubber rub rail all around the top edge of the hull. Obtain a piece of black neoprene tubing, 3/16" outside diameter, about 54" long. The tubing is usually available wherever model engines are sold because it is frequently used for fuel lines. Slit the wall of tubing along its full length with a new single-edge razor blade, keeping the cut as straight as possible. You will install this rub rail later, as part of

When trimming excess plastic along the edges of the vacuum-formed hull, leave a lip for a rub rail to be made from black neoprene fuel tubing.

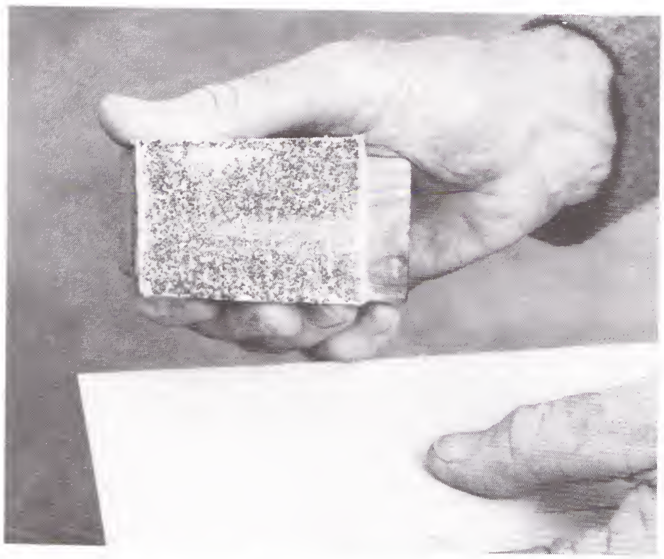
Step 6. Follow the rest of the instructions in Step 4.

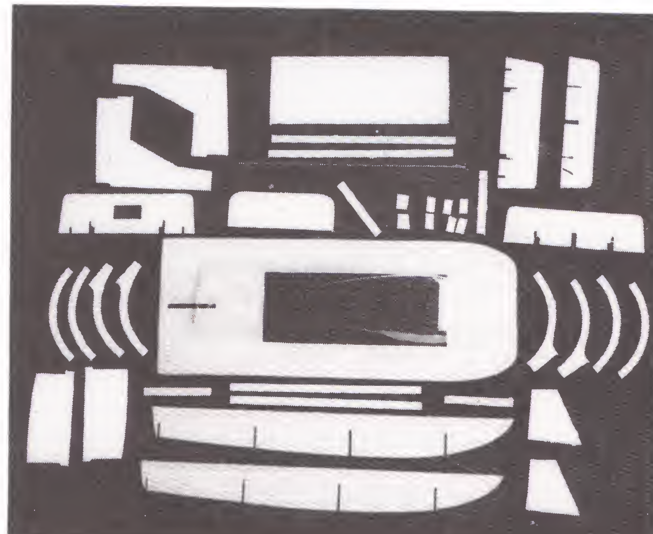
Then, before proceeding to Step 5, set the hull in water and press it down until it is almost completely submerged. Hold it in the water for 15 seconds or so to make sure the seal you made at the plastic wheel well and the opening in the hull at what the instructions call the "vertical wall" does not leak. If it does, dry the area thoroughly and apply more glue until the seal is watertight.

The kit instructions do not call for installing the main wheels until Step 7. There's nothing wrong with that, but it's easier to install the wheels before you put the decking in place, so I recommend installing the wheels as the last stage in Step 5. Put the wheels in place and check that they don't rub against the sides of the wheel wells (use washers for spacers as necessary). Test once more for leaks.

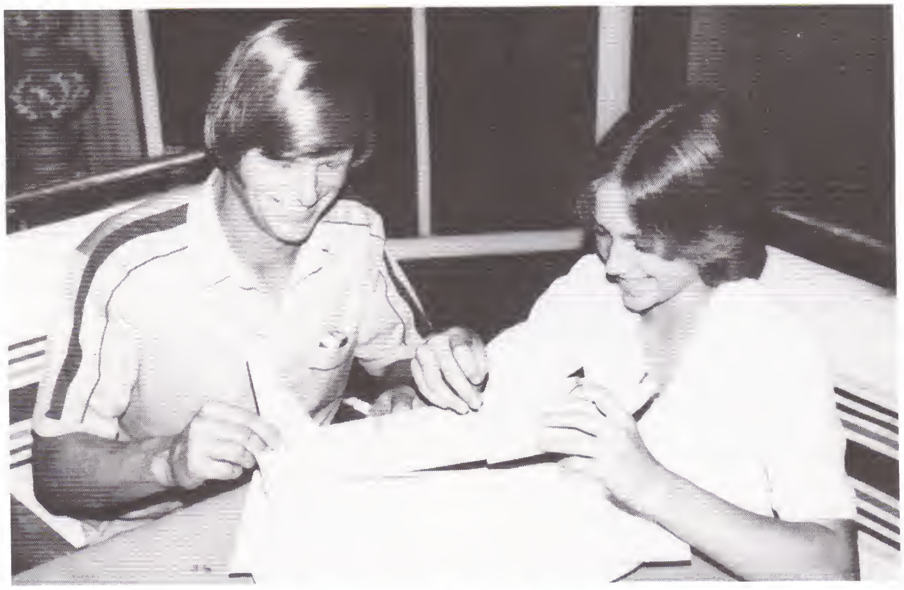
Install the deck and hatch cover as called for in Step 6, then slip the neoprene tubing rub rail in place on the molded lip.

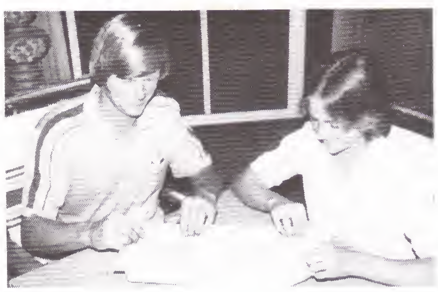
Step 7 is easy to follow, but here are



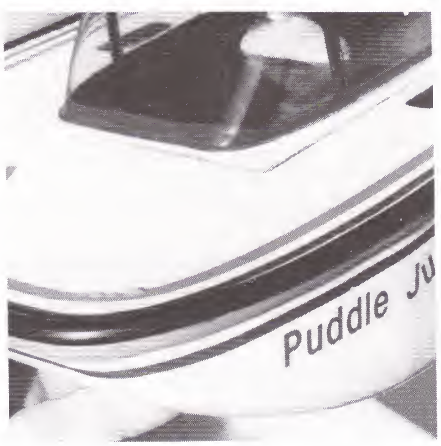


In die-cutting, steel blades (dies) shaped to the outline of the kit parts are forced against balsa or plywood sheets. If the dies are slightly dull or the wood is exceptionally tough, the wood may not be completely cut through. (Top left) In that case, prepare a sanding block by gluing coarse-grit sandpaper to a piece of hardwood. (Top right) Sand the back of each die-cut sheet until the parts become free. (Above left) You may have to cut along the edges of some stubborn parts with an X-acto knife. (Above right) These are the die-cut parts for the Puddle Jumper after I removed them from the sheets.





A wooden frame stiffens the hull and provides a base for the deck, hatch cover, and engine pylon. Align the frame, then install it and the wheels before gluing on the deck.



Two shots of the completed Puddle Jumper showing (left) the shiny rub rail and (right) a Goldberg nylon wing tip skid glued to the hull with silicone sealant.

a couple of hints. Locate the propeller safety ring to suit your engine. For example, the tank on a Babe Bee is shorter than that on a Black Widow, so for a Babe Bee the ring must be slightly farther aft.

The plans show wire corner skids: On my Puddle Jumper, I substituted Goldberg nylon wing tip skids. They look good, don't rust, and are easier to install; just glue them in place with clear silicone sealant.

The instructions say "paint to taste." That's fine. I suggest you leave the hull in its natural white color and decorate it with plastic striping tape. The tape is easier and looks more professional unless you are an expert painter.

In order to prevent fuel and exhaust from attacking the paint on the clear plastic cabin, borrow a trick from the radio control car enthusiasts and apply the paint to its inner surface. Mask off the window areas, then brush or spray on the paint of your choice.

The kit supplies polyethylene plastic rudder hinges; don't use these unless you plan to install radio control. Otherwise, make the hinges from pipe cleaner wire so that the rudder will stay at any given setting.

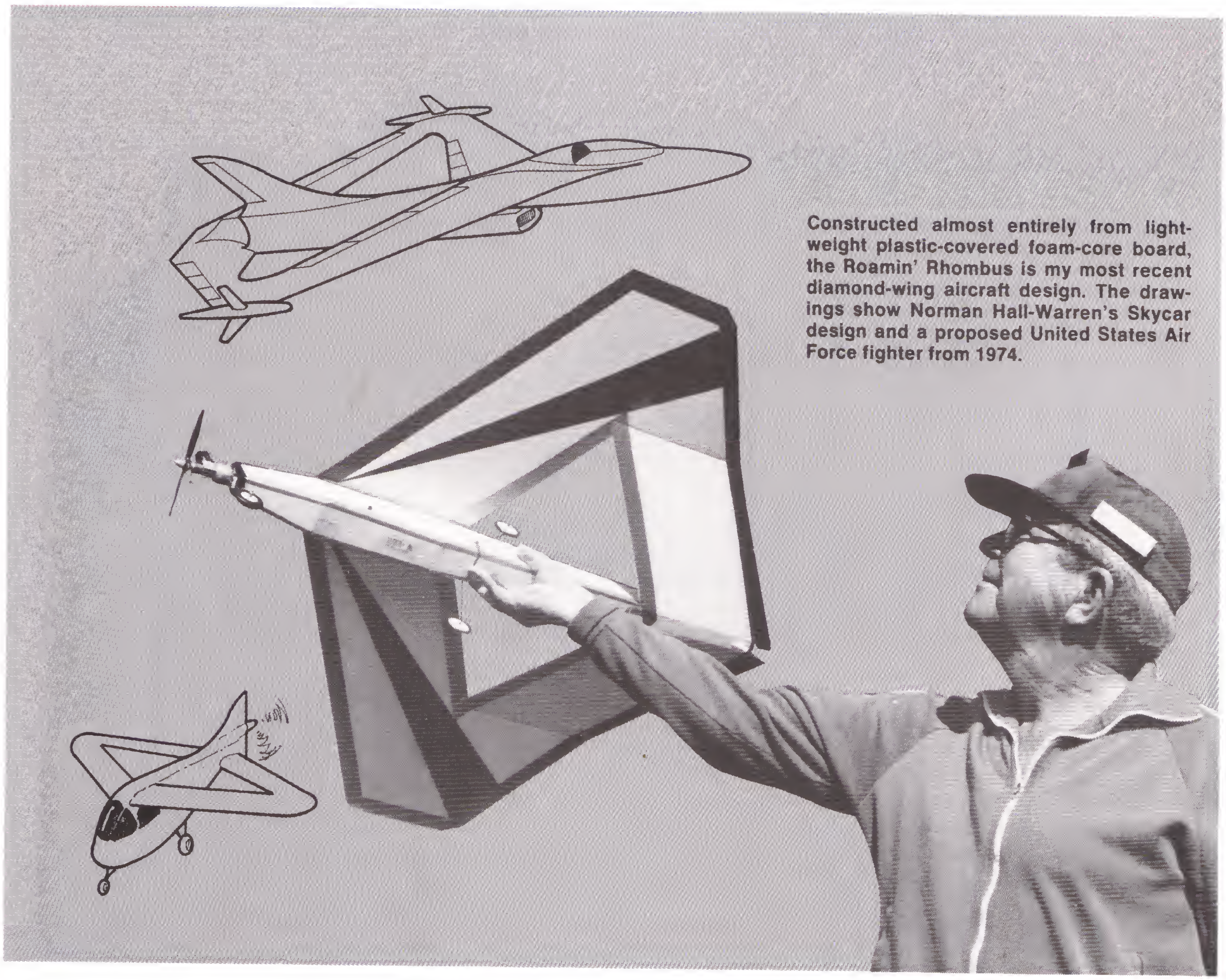
Operating the Puddle Jumper. Install radio control, let the model run free, or use a 25-foot tether as shown on the plans. If you want to let it run free, you'll need a large, unobstructed, flat surface. Begin with the engine running slowly at a rich needle valve setting or at normal speed but with the prop on backwards. For the first tests, you may even want to run the engine both rich and with a reversed prop; doing so will cut the thrust so much that the Puddle Jumper will barely move.

Keep in mind that our reed-valve .049s run equally well backwards or forwards, so be sure you feel the thrust of air behind the propeller instead of in front of it. If you don't and the Puddle Jumper goes backwards, it will probably capsize.

Here's one final tip: If the Puddle Jumper ever capsizes, dry out the engine thoroughly and check to see if the glow head is still good. When the boat capsizes the glow head sometimes cools so fast that its wire breaks.

Project 7

The Roamin' Rhombus



Constructed almost entirely from lightweight plastic-covered foam-core board, the Roamin' Rhombus is my most recent diamond-wing aircraft design. The drawings show Norman Hall-Warren's Skycar design and a proposed United States Air Force fighter from 1974.

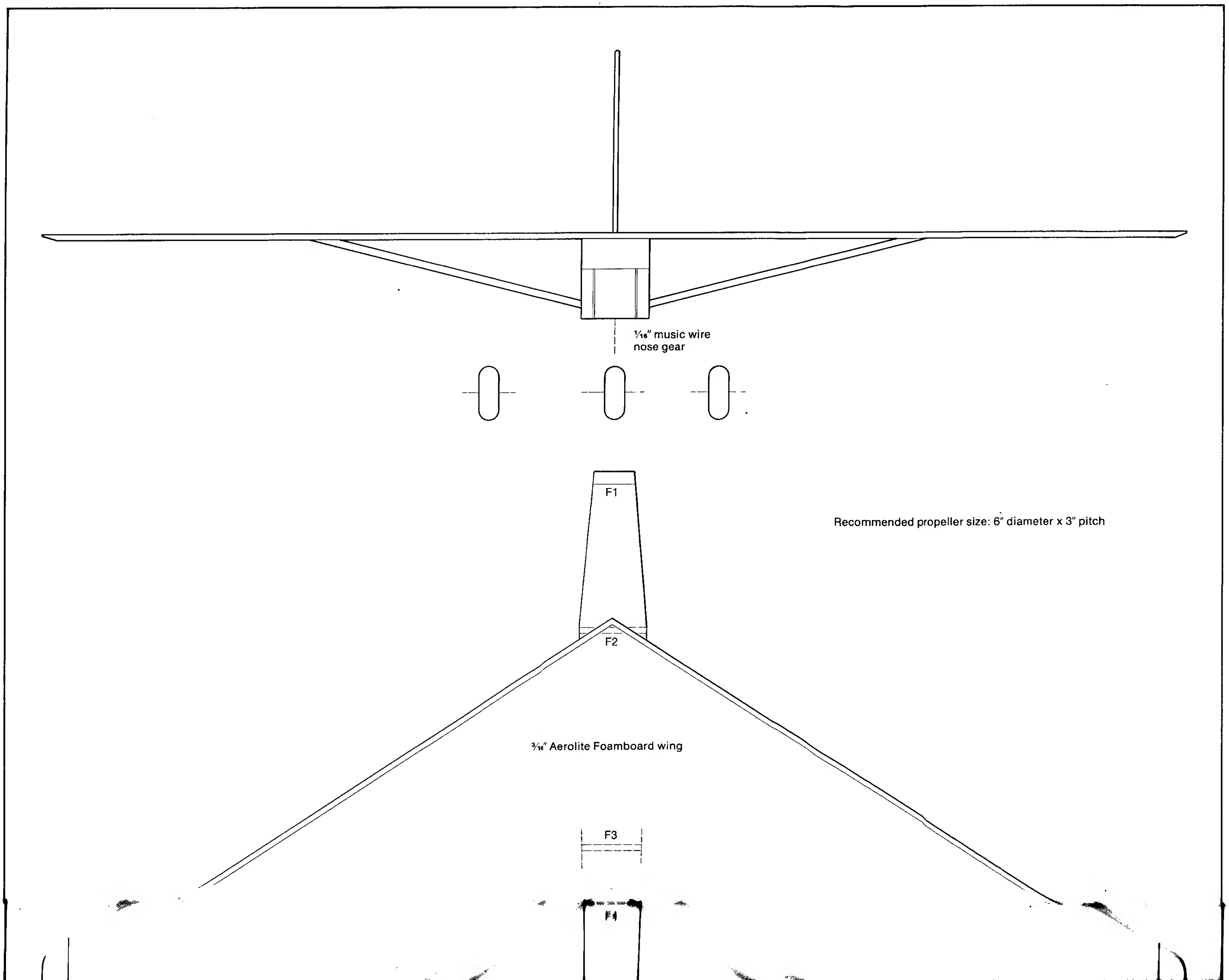
As the saying goes, "Someone is always reinventing the wheel." That tendency is especially true in the field of aviation where "new" concepts keep springing up regularly. As an example, consider all the ultralight airplane designs. Each designer claims "this concept is new and has many advantages over conventional types." But a look at the efforts of such men as Otto Lilienthal, Octave Chanute, Orville and Wilbur Wright, John Stringfellow, and other pioneers shows that there are virtually no really new designs, just variations of old concepts. Even Leonardo da Vinci's designs could have flown if a suitable power source had been available. See what I mean?

The diamond-wing configuration is one of the best examples of "new is old." The original diamond wing was conceived in 1926 by Norman Hall-Warren, an English experimenter. He patented the concept in 1937 but was unable to raise enough money to build a full-size, man-carrying version, even though many free flight and RC models were successfully flown.

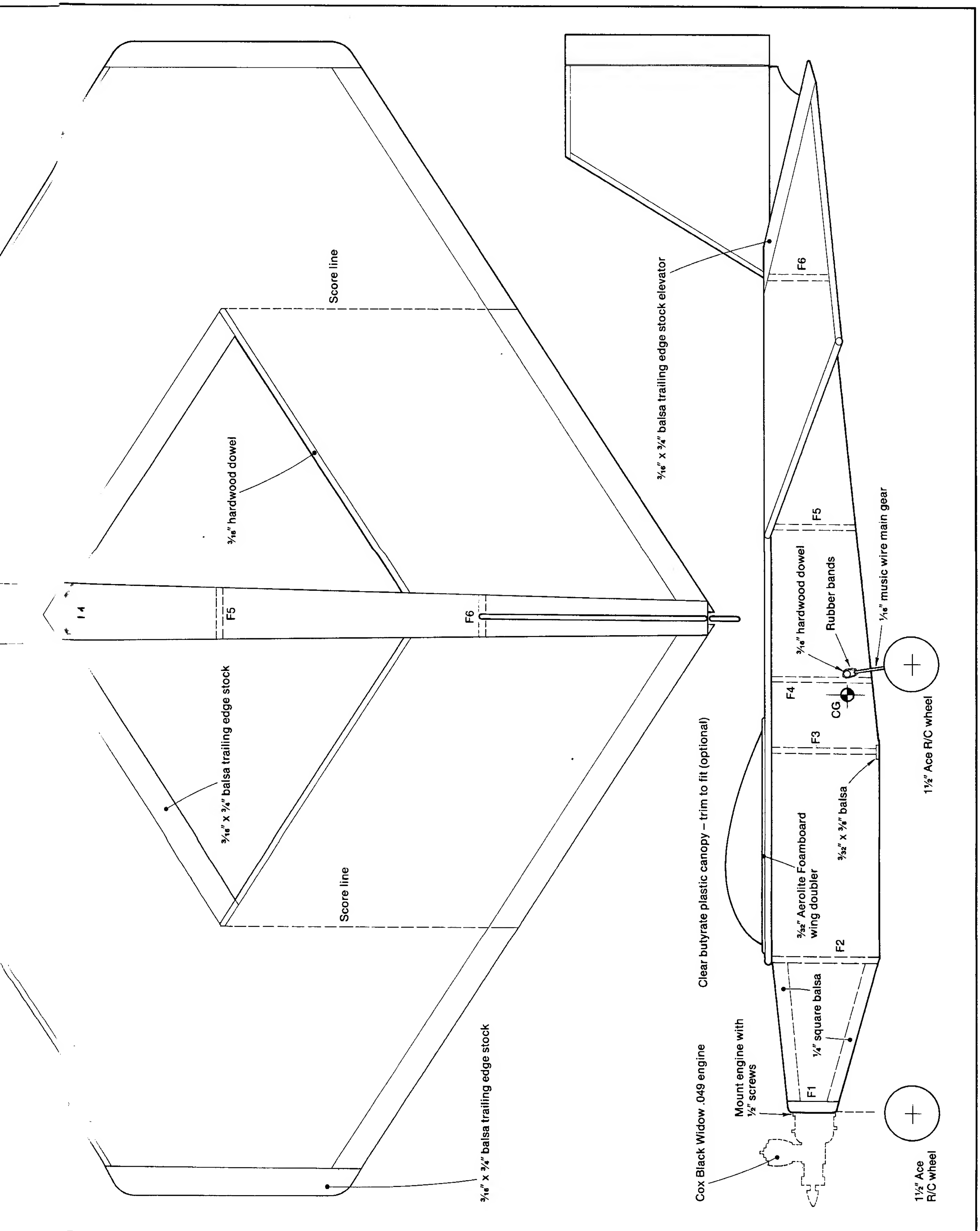
In 1974 the U. S. Air Force announced an "advanced aircraft design." It was nothing more than an updated version of Norman Hall-Warren's basic layout. In 1982 Burt Rutan, the brilliant designer of several unorthodox aircraft including the Vari-Eze, came out with the Predator, a rhombus-wing aircraft with some added wingspan at the tips. All new — and all old — insofar as the basic concept is concerned.

It is interesting to note that one of the claimed advantages of the rhombus-wing airplane is that it will not stall or spin. When it loses flying speed, it mushes forward and the nose drops until flying speed is regained. Radio control models confirmed this during test flights. They were stable.

Plans for rhombus-wing models have been published before. In August 1969, *R/C Modeler* magazine published my design for a scale model of Norman Hall-Warren's Skycar. I performed test flights with this model for Hall-Warren that confirmed his faith in the concept.



1/16" music wire
nose gear
F1
Recommended propeller size: 6" diameter x 3" pitch
F2
3/16" Aerolite Foamboard wing
F3
F4


Score line
3/16" hardwood dowel
3/16" x 3/4" balsa trailing edge stock
F5
F6
Score line
3/16" x 3/4" balsa trailing edge stock
3/16" x 3/4" balsa trailing edge stock elevator
F6
F5
3/16" hardwood dowel
Rubber bands
1/16" music wire main gear
F4
CG
F3
Clear butyrate plastic canopy – trim to fit (optional)
3/32" Aerolite Foamboard wing doubler
3/32" x 3/8" balsa
1 1/2" Ace R/C wheel
F2
1/4" square balsa
F1
Mount engine with 1/2" screws
Cox Black Widow .049 engine
1 1/2" Ace R/C wheel

The plane can take off from a paved surface or you can hand launch it. To minimize the chances of a flyaway, adjust the rudder for gentle turns in both powered and unpowered flight and keep the engine runs short, not longer than 30 seconds.

In 1976, *Model Builder* magazine published a small free flight variation. It was powered by the Cox .010 engine, which is no longer available; otherwise it would have been a good subject for this book. However, I think this "new" design, the Roamin' Rhombus, will please you, since it is easy to build and fly.

This model has a 33½" wingspan and a fuselage length of 34"; it's a free flight version of my .049-powered Roamin' Rhombus for three-channel radio control that was published in the September 1982 issue of *R/C Modeler*. (Full-size plans, No. 874, of the RC version are available from the magazine; the address is on page 48.)

One feature of the Roamin' Rhombus that really is new is the material from which it is made — Aerolite Foamboard. In 1981 a materials and structures engineer, Jim Moynihan, working with a plastics firm came out with Aerolite Foamboard in 1/16", 1/8", 3/16", and several other thicknesses suitable for use in aeromodeling. It differs from most other foam-core boards in that both sides of the styrene foam core are covered with .004"-thick ABS plastic instead of paper. It is fuel-proof and waterproof, roughly equal in weight to medium-grade balsa, and can be painted with polyurethane-base paints.

Jim also came out with a special adhesive, Fas-Tac, which works well with Foamboard. The material can also be bonded with white glue, Titebond, and epoxy. You can use instant glue on the ABS surfaces but not on the core because instant glue dissolves styrene foam.

You can order Foamboard directly from Aerolite Products (a catalog costs $1.00); all of the other materials for the Roamin' Rhombus are standard hobby shop items. As I mentioned in the first chapter, if you can't obtain Aerolite Foamboard, you should be able to order an equivalent product from plastics stores such as TAP and many art supply stores.

The Bill of Materials lists the supplies you'll need in addition to glues and paints.

Construction. Make the wing from a 3/16" x 16" x 48" sheet of Aerolite Foamboard. Cut the material with a single-edge razor blade, holding the blade perpendicular to the Foamboard and using a steel straightedge as a guide.

Next place the two panels together on a flat surface so they form the rhombus. At the forward apex, put waxed paper under the joint, and butt glue the panels together. Then cover that joint with a doubler of 1/8" Aerolite, 2" wide at the front and 1¾" wide at the rear, and glued in place along the center line. When the glue dries, trim the doubler to the angles of the front and the rear of the forward wing. Do not glue the rear apex together.

Now look again at the plans. You will see a score line extending from the inner angle where the front wing trailing edge meets the rear wing leading edge back to the trailing edge of the rear wing. The score line is parallel to the center line. This is the line where the wing is bent down so that the rear section can be attached to the bottom of the fuselage.

To score the Aerolite, run a No. 2 pencil gently along the line, using a steel straightedge as a guide. Press just hard enough to indent the covering without going through to the core. Practice on scrap first. Next, carefully bend the material along the score line.

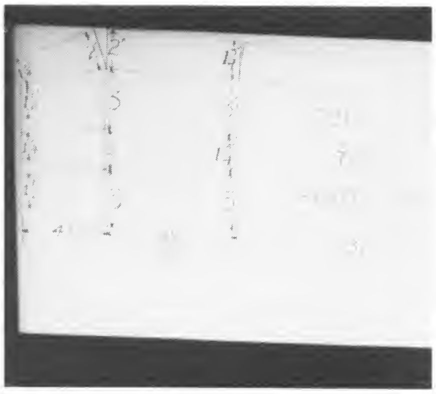
Set the wing panels aside and make the fuselage from a 1/8" x 16" x 48" sheet of Aerolite. The drawing shows lofting lines you can use to make the fuselage sides, top, and bottom from one piece. If you prefer, you can cut out separate pieces for the sides, top, and bottom and glue them together with white glue, Titebond, Fas-Tac, or epoxy just as if they were pieces of balsa.

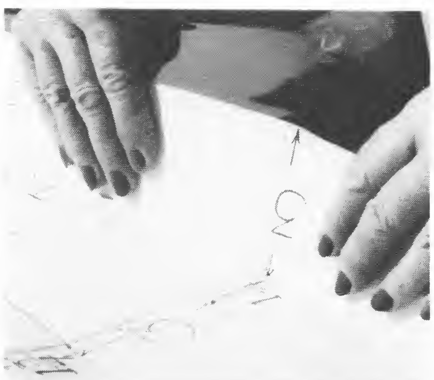
I favor the one-piece method because only one joint has to be glued. Here's how you do it, using the lofted lines. Cut out the fuselage in one piece, cutting along the outer lines of the lofted layout first. Next score the straight lines which separate the top from the sides and the straight line which separates the bottom from the left side. Now bend the sides up and the bottom over, wrapping the surfaces into a box-like section. Let the surfaces spring back slightly and mark the locations where the bulkheads will go.

Measure the inside width of the top panel and prepare rectangular bulkheads that fit snugly against the sides, bottom, and top. Make the bulkheads from 3/16" balsa or 3/16" Aerolite. I used balsa because I wanted to glue the bulkheads to the sides with instant glue. If you make the bulkheads from Aerolite, you'll have to glue them to the sides with a glue that doesn't dissolve styrene since the edges of the bulkheads expose the foam core. If you don't use balsa bulkheads and instant glue, brace the fuselage in some sort of jig while the glue dries.

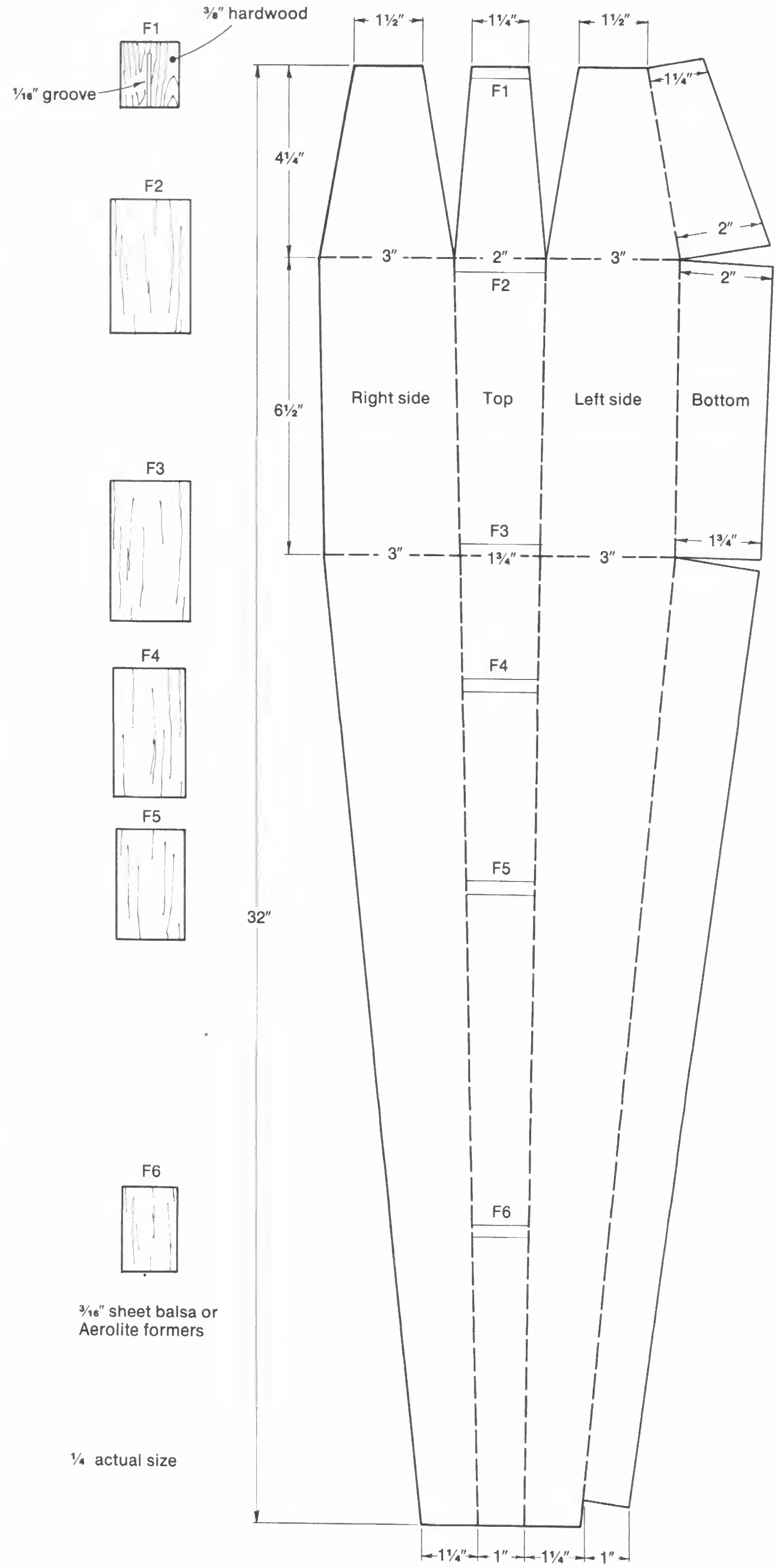
Secure bulkheads F2 through F6 to the top and sides, but don't close the bottom yet.

Add the ¼" x ¼" braces to the nose section. Bend both sides along the vertical score line just in front of F2 until they press against the forward top section, which must be bent slightly downward; then epoxy the top of each side to the top panel. Epoxy the nose block, F1, to the forward end of the fuselage. Before applying the epoxy, gently sand the ends of the ¼" x ¼" braces so they fit flush against the nose block. Also, as you epoxy the assembly together, hold the ends of the sides and top pieces so they are flush with the edges of the nose block. One way to do this is to pin



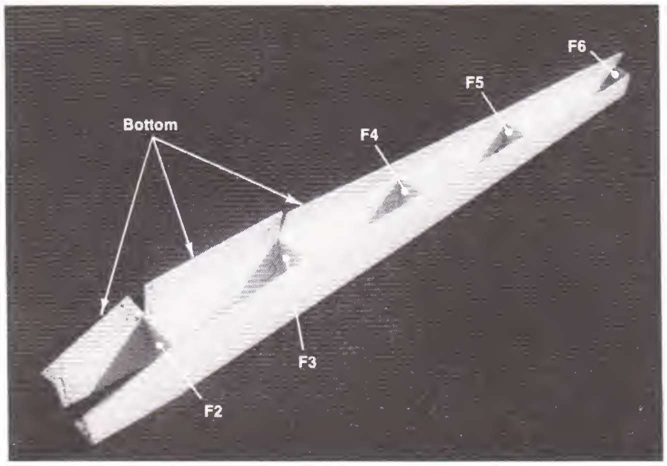


(Top) Feel free to mark up the ⅛" Foamboard with as much information as you want — your scribblings will be invisible after you've folded the fuselage. (Second from top) Cut the Foamboard with a single-edge razor blade held vertically and guided by a metal straightedge. (Third from top) Score along the lines where the material will be bent with a dull No. 2 pencil. (Above) Foamboard has virtually no grain, so bends along the scored lines equally well in any direction.

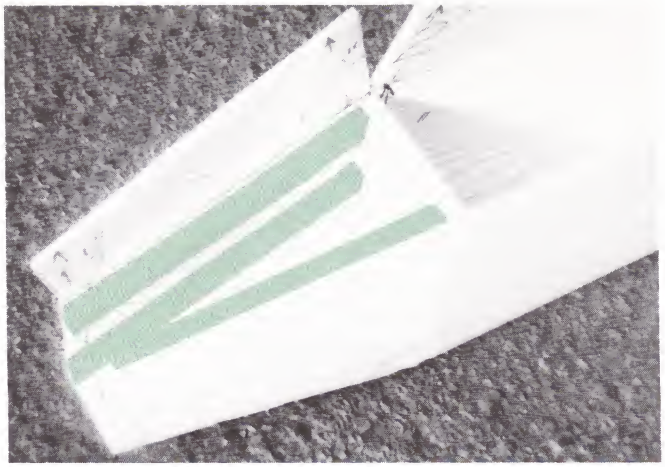


Score and fold along dashed lines.

FUSELAGE LOFTING LINES AND BULKHEAD PATTERNS



(Left) I've installed bulkheads F2 through F6 and will now close up the bottom from F2 to the tail and then prepare the nose.



(Right) Reinforce the nose with ¼″-square balsa sticks (colored in photo) at each corner. The fire wall will butt against the sticks.

the surfaces together while the epoxy is still wet. Remove the pins after the epoxy dries.

Close up the bottom of the fuselage. Fold the bottom over, check to make sure that the structure is square and untwisted, then glue the bottom in place. Use white glue, Titebond, Fas-Tac, or epoxy, because the core will be exposed to the adhesive.

Now it's time to make the main landing gear attachment. Note on the plans how a 3⁄16″ dowel goes transversely through the fuselage and is glued to the rear of bulkhead F4. The ends protrude ½″ on either side and the wire landing gear is held to the fuselage with rubber bands wrapped around the wire and the ends of the dowel. Don't snug up the rubber bands too tightly or the landing gear wire will crush the bottom of the fuselage. If this should happen, just put a ½″-wide reinforcing piece of 1⁄16″ plywood over the crease and epoxy the plywood in place.

The nose gear is made later when you are working on the engine installation. Also, for the time being, don't strap on the main gear. It will get in the way as you handle the fuselage while mounting the wing, which is the next step.

Bill of Materials

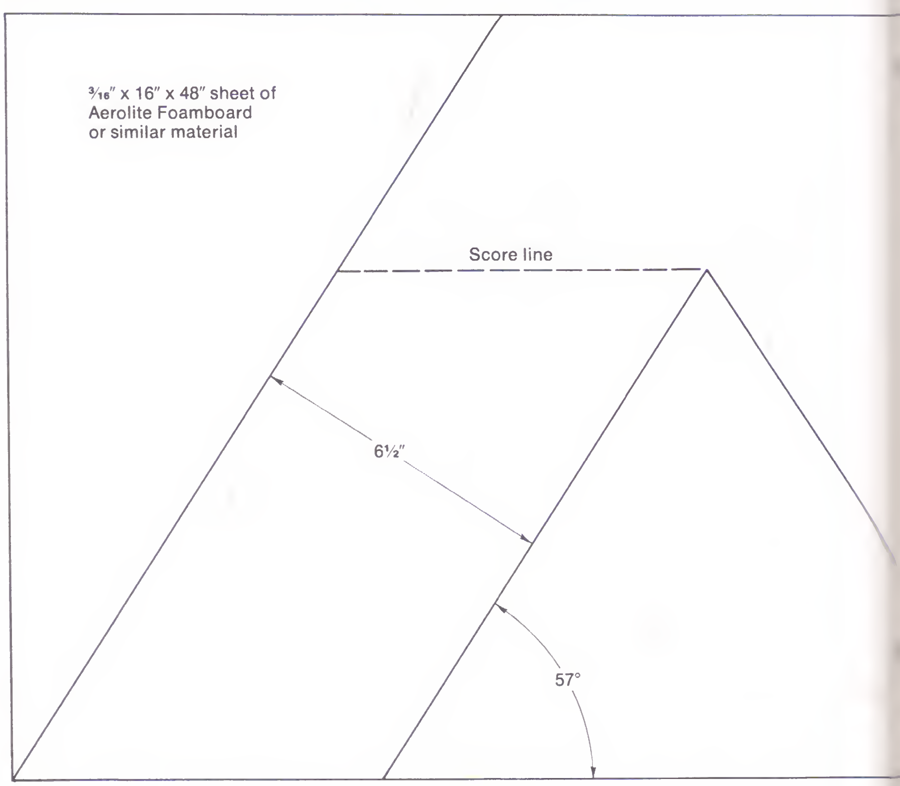
- A 3⁄16″ x 16″ x 48″ Aerolite Foamboard sheet or equivalent
- A ⅛″ x 16″ x 48″ Aerolite Foamboard sheet or equivalent
- A 3⁄16″ x 3″ x 12″ balsa sheet
- Three 3⁄16″ x 36″ dowels
- Three pieces of 3⁄16″ x ¾″ x 36″ balsa triangular trailing edge stock
- A ¼″ x ¼″ x 36″ balsa strip
- A ⅜″ x 1¼″ x 2″ basswood or pine block
- A 14″ piece of 1⁄16″ music wire
- Three 1½″ wheels
- Five 1⁄16″ wheel collars
- A plastic canopy (optional)

You may wonder why the wing is mounted even before the leading edge dowels and trailing edge pieces have been attached to the Aerolite. The reason is that you can fit those parts better after the wing sheets are mounted to the fuselage.

You can, however, prepare the leading edge of the Aerolite sheet to accept the leading edge dowel at this time. When you cut out the sheet, the edges were straight up and down, but you want them to be concave so the dowel will fit well. To get that shape, run the end of a dowel along the edge of the sheet; press firmly with the dowel and compress the foam to a curved shape.

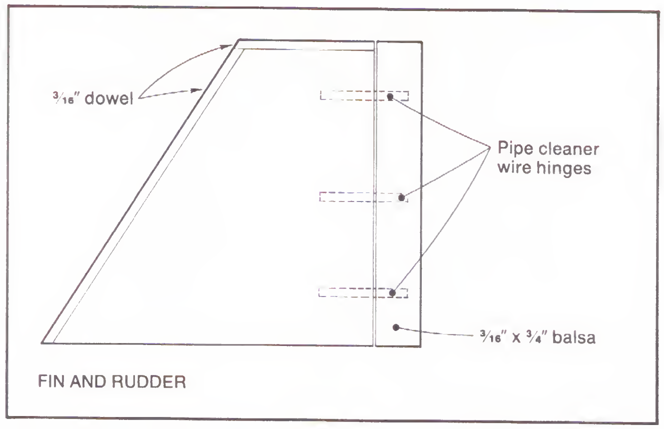
Now let's mount the wing. Mark the location on the top of the fuselage where the wing sheet goes. Bend the rear sections of the wing down at the score lines, then locate the wing on the fuselage at the forward apex, with the rear sections bent down so they are at the bottom of the fuselage. There is a gap where the wing sheet meets the bottom of the fuselage. Don't try to close the gap by pulling on the sheet; doing so would distort the wing.

Glue the forward section of the wing in place on top of the fuselage and let it dry. You'll have to twist the rear sec-



WING PANEL LAYOUT ¼ actual size

Transfer the wing patterns to the Foamboard but don't make any marks on the material that will become the wings.



FIN AND RUDDER

tions of the wing slightly to ensure that the wing fits flat against the bottom of the fuselage. The twist also helps stabilize the plane in flight — it produces the correct angular difference between the forward and the rear wing sections. When the glue at the joints between the edges of the fuselage and the rear sections of the wing touch has dried, you can fill the gap across the fuselage with a piece of scrap 3/16" Aerolite.

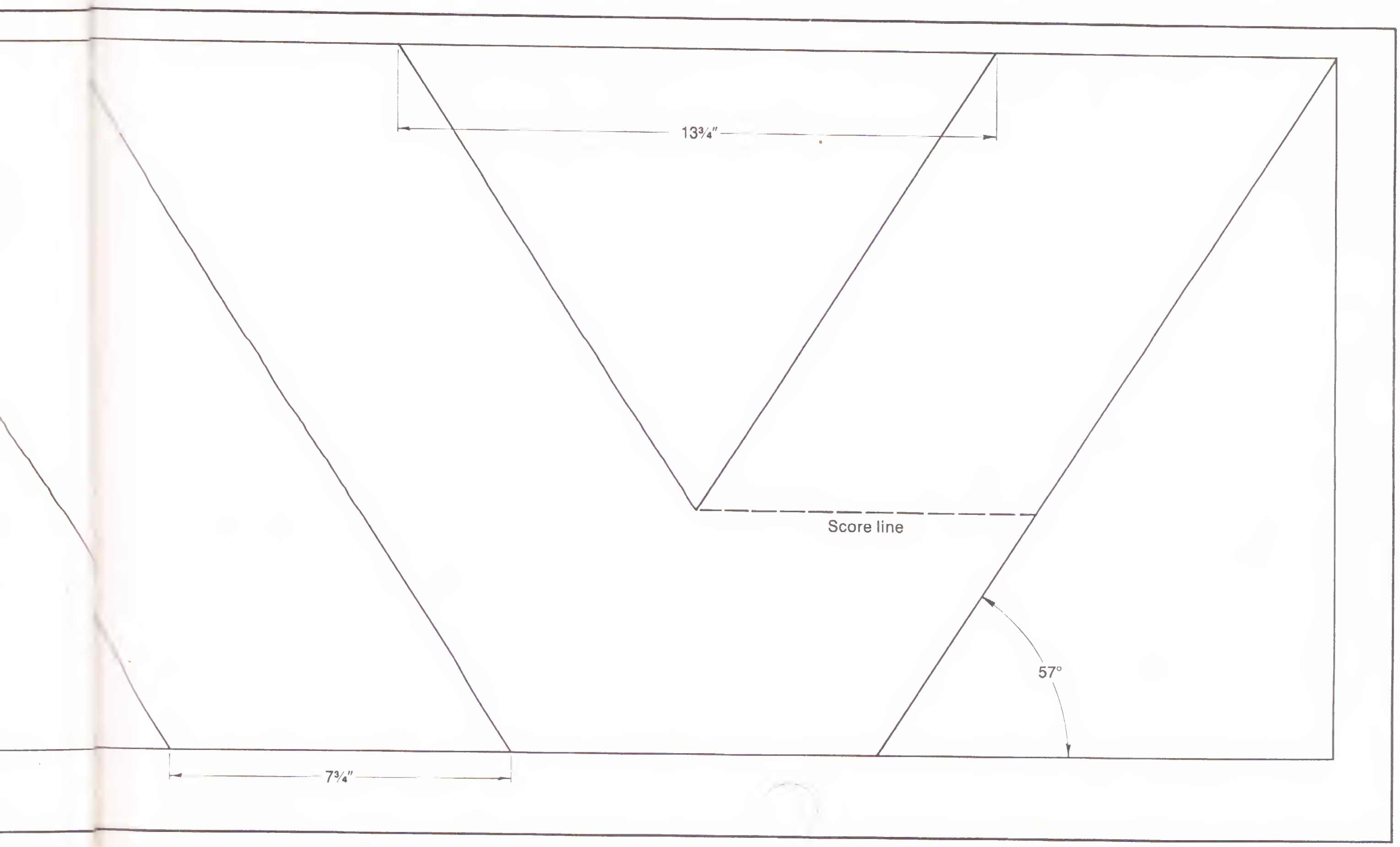
The model is beginning to look like the Roamin' Rhombus now, but there's still a bit of work ahead. Let's finish the wing structure leading and trailing edges with the dowels and balsa trailing edge stock. Cut the dowel to the correct length for each section, run a bead of Fas-Tac or Titebond along the concave leading edge, press the dowel in place, and hold it there with short strips of masking tape while the glue dries. Of course, the ends of the dowels have to be cut at the correct angle so they butt together at the apex of the leading edge of the forward wing and at the inner angle where the leading edge of the rear section meets the trailing edge of the forward wing.

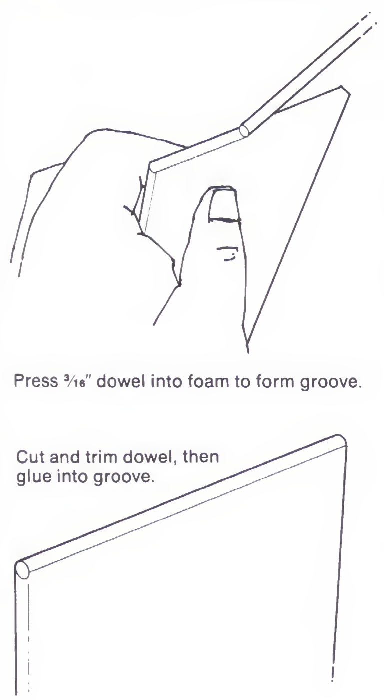
Next glue the 3/16" x 3/4" trailing edge stock to the rear of the wings and at the tips. Note that the bottom of the trailing edge stock is in line with the bottom of the Aerolite sheet, except that it is reversed at the tips. Use masking tape to hold the trailing edge stock in place while the glue dries.

Now you have the wing and fuselage assembly finished and it's time to add the fin and rudder. Cut the fin out of the 3/16" Aerolite (there's plenty left on the original sheet) and butt glue it to the top of the fuselage with white glue, Titebond, or Fas-Tac. Make sure it is in line with the center line of the fuselage and perpendicular to the top of the fuselage. Then glue the 3/16" dowel to the front edge and top of the fin as shown on the plans.

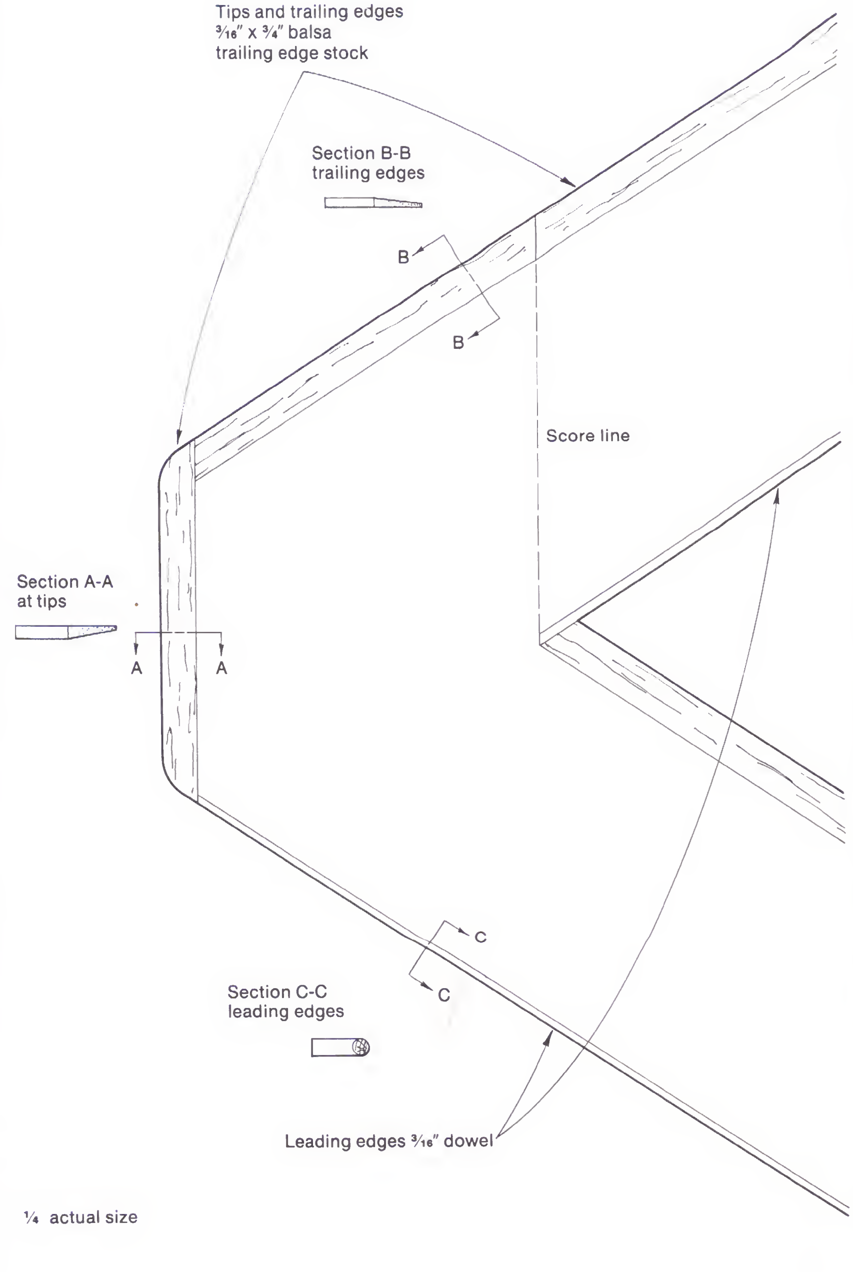
The next step is to attach the rudder to the fin. The rudder can be cut out of 3/16" balsa or Aerolite. Make the hinges from three pieces of pipe cleaner wire about an inch long and install one at the top of the fin, one in the middle, and one at the bottom. The pipe cleaner wire hinges will hold the rudder at whatever setting you choose when flying the model.

The canopy is optional but you have





PREPARING THE LEADING EDGES



WING LEADING AND TRAILING EDGES

to admit it gives the model a jet age, futuristic look. Buy a canopy at a hobby shop, cut it to shape, and attach it to the top of the fuselage with instant glue.

Similarly painting and decorations are optional; I left my Roamin' Rhombus unpainted and decorated it with bands of Trim Monokote, a self-adhesive plastic film sold in 6″ x 36″ sheets; many colors are available.

Drill a hole in the nose block for the end of the nose gear and cut a 1⁄16″ groove vertically from the hole to the bottom of the block. The 1⁄16″ wire nose gear fits in this groove and is held in place by the engine's backplate when the engine is mounted.

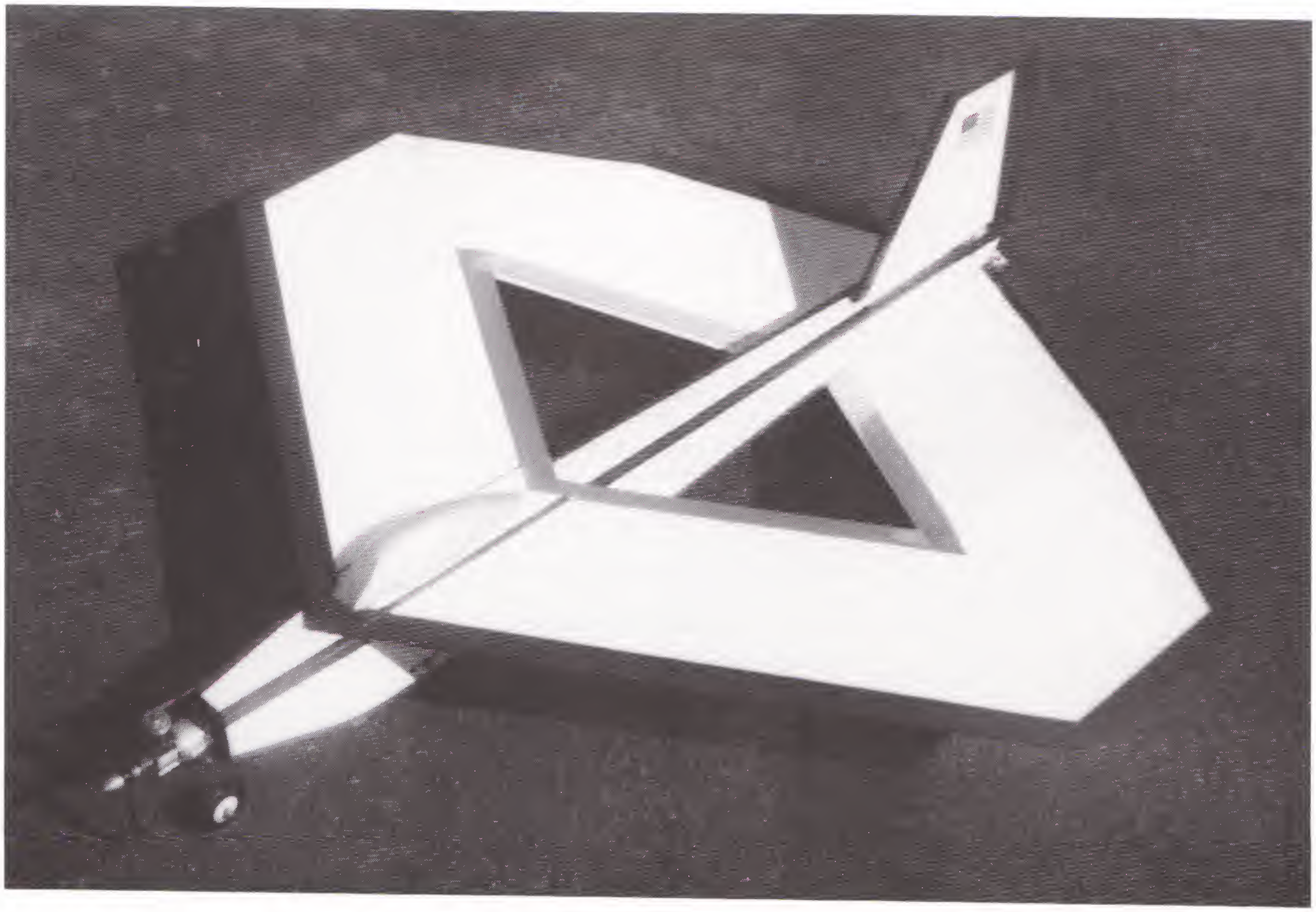
Attach the engine to the nose block with four wood screws, strap on the main landing gear with rubber bands, and you are ready for the first test glides.

Test flights. Before making any test glides, give the Roamin' Rhombus a careful preflight checkout. Note the balance point shown on the plans. Hold the model under the wing with your index fingers right above the balance point. The model should hang level. If it doesn't — and the odds are that it won't — ballast the model as necessary. Add weight to the nose in case the model balances nose high. If the model hangs nose down, add weight to the tail. In either case, add just enough weight to make the model hang level. Use masking or strapping tape to hold on the weight for the first tests; you may later want to change the amount depending on the glide path.

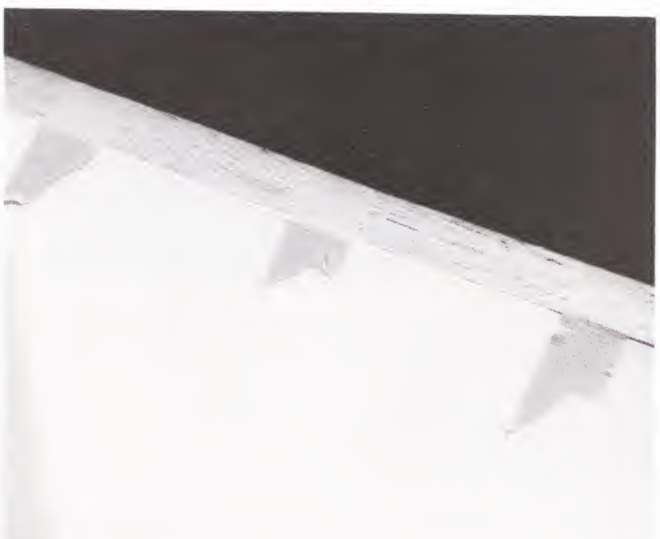
Hold the model in front of you at arm's length and sight down the center line. Is the fin lined up with the center line and is it perpendicular to the top of the fuselage? If not, break off the fin and reglue it properly. Otherwise the model will fly erratically and the resulting crash will be a lot more bothersome than setting the fin correctly in the first place.

Also, while checking the alignment of the fin, check the wings. Make sure there are no unwanted twists, particularly in the forward wing. For the glide tests, pick a quiet day when the wind won't affect the glide path. Launch the Roamin' Rhombus level, straight ahead, and at a moderate speed. If it is properly balanced, it will glide level for a few feet, then the nose will drop slightly and the model will glide gently to earth.

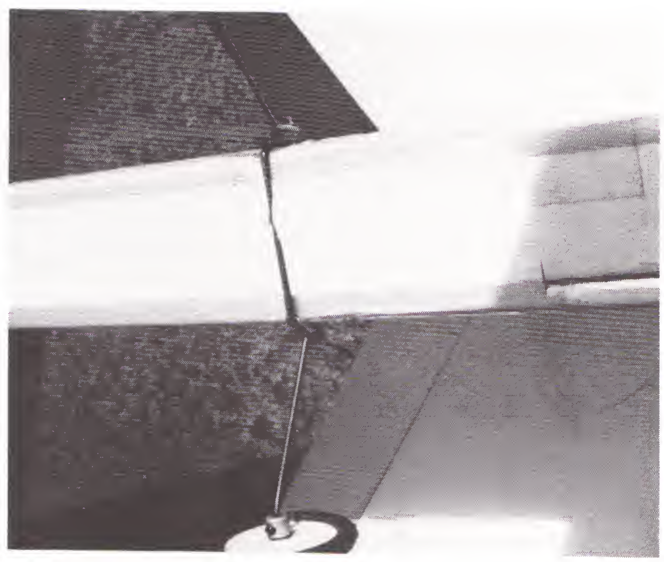
If the nose drops rapidly and the model dives toward the ground, add weight to the tail. If the nose rises rapidly shortly after launch and the model



The Trim Monokote along the leading and trailing edges dresses up the model, as do the canopy and the flag decal on the fin.



Hold the balsa trailing edge pieces in place with masking tape while the glue dries. To ensure correct flight performance, orient these pieces as shown in the drawings.



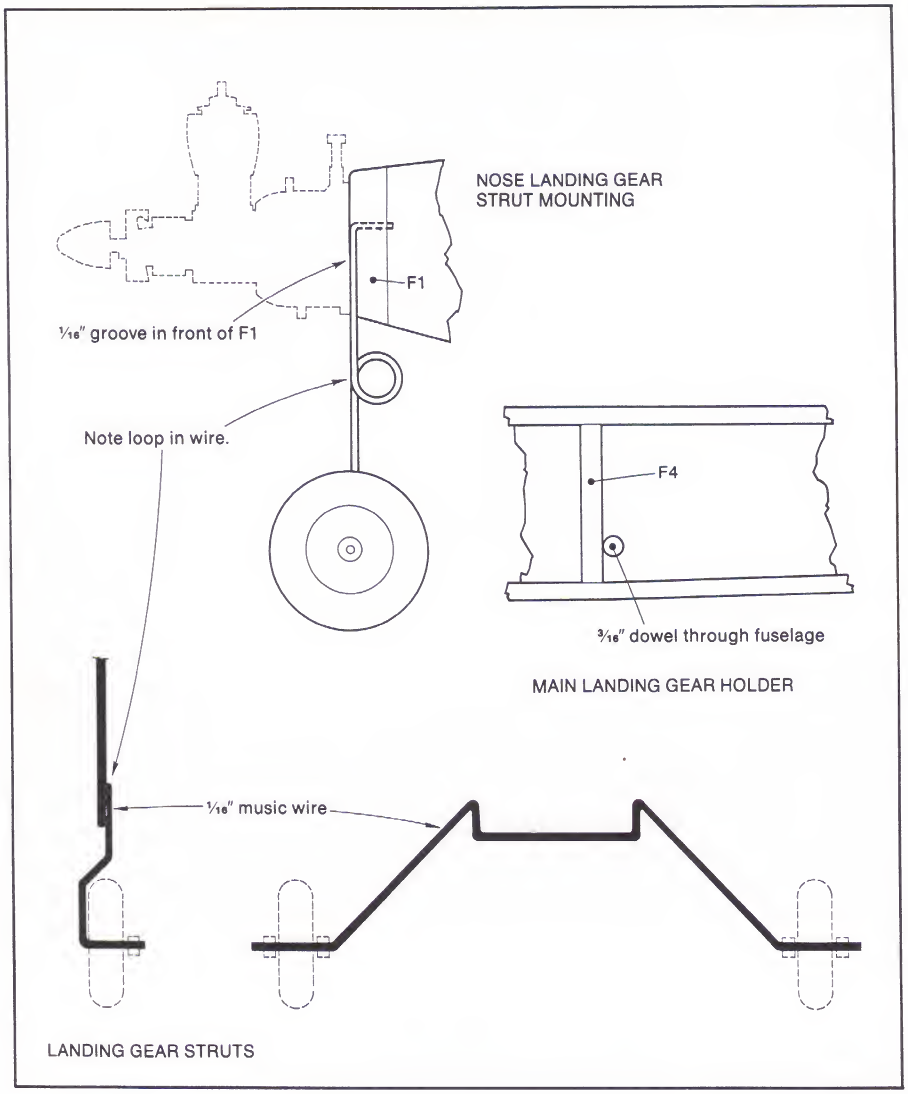
The rubber bands that secure the main landing gear to the fuselage also act as shock absorbers. The rubber bands soon become frayed, so replace them frequently.

then hesitates and dives toward the ground, add a little weight to the nose. Each plane will behave differently, depending on what kind of and how much glue you applied, what grade of balsa you used for the trailing edge stock, and other variables.

After you've got the model gliding gently to the ground in a straight path, you are ready for the first powered flights. Don't run the engine at full power. Either adjust the needle valve so the engine is sputtering at a slightly rich setting or mount the propeller backwards.

Don't completely fill the tank. Just put in enough fuel to run the engine for about 15 seconds. In fact, that's a good practice all the time unless there's no wind. The engine will run almost two minutes on a full tank and the plane could go out of sight.

Start the engine, then launch. The model should leave your hand straight and level, gain speed, start a gentle climb in a slight left turn, continue climbing in a left turn until the engine



stops, and then glide down. If the model leaves your hand, goes into a left turn and spirals into the ground, pick it up, make whatever minor repairs may be required, and try again, only this time bend the rudder just a tad to the right — say about 1/32" at the trailing edge. Try another flight at low power. If the model still winds in to the left, add a bit more right rudder, say another 1/32", and see if that cures it. It should, if all your surfaces are in good alignment.

Suppose the model leaves your hand, goes straight ahead nose up, swoops down, repeats, and finally hits the ground during one of the swoops. Bend the rudder slightly to the left and try again until you achieve a gentle climbing turn to the left under power.

Once you get the proper rudder setting, you can gradually increase the power on subsequent flights. Each such increase may require a slight adjustment in the rudder setting, since the propeller's slipstream will increase the effect of any offset you may have put in the rudder. This will not be true if your model is well aligned to begin with — in that case the model will simply climb faster as you increase engine speed.

In any event, when you go out to fly, be ready for lots of attention. The Roamin' Rhombus never fails to attract comments, but keep the engine runs short or one of the comments may be "Hey, it went out of sight!" Then, unless you're lucky and it glides back where you can see it, you'll just have to build another.

Project 8

The Blue Angels

There are many famous aerobatic teams. To name a few, there are the U. S. Air Force Thunderbirds, Canadian Armed Forces Snowbirds, Royal Air Force Red Devils, and a civilian group of American pilots called the Christen Eagles. Without question, however, the world's most famous aerobatic team is the United States Navy's Blue Angels. Their mission, officially, is to "demonstrate United States Navy air fighter tactics to United States citizens at public demonstrations of U. S. Navy capabilities for fighter defense." In order to demonstrate to the taxpaying American citizen that his money is being well spent to train the world's best pilots, the Blue Angels travel far and wide throughout the United States to show the high degree of proficiency required of Navy pilots.

Over the years the Blue Angels have used several types of Navy fighters and as these planes became faster and faster the maneuvers became more and more breathtaking. However, when they progressed to the supersonic F-4J Phantom II, two things became evident. One was that the Phantoms used a lot of fuel. The other was that the planes required too much airspace for regrouping after maneuvers — they were out of sight of their audience much of the time. So, in 1974 the Navy decided to use the smaller, somewhat slower but still spectacular A-4F Skyhawk and the Blue Angels are still flying this plane.

The Blue Angels are four profile models of the A4-F Skyhawk powered by a single .049 engine and flown on a 20- to 25-foot tether. Here's one project that can't get away!

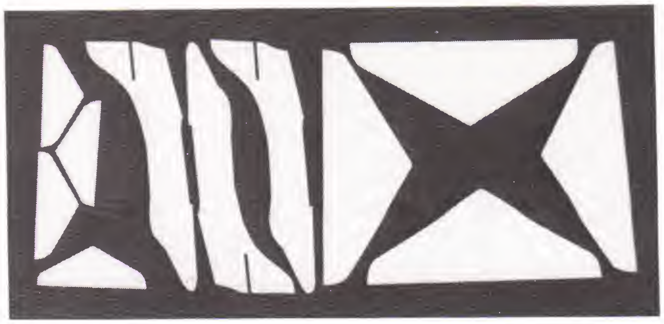
Naturally, I chose the Skyhawk when I decided to build a set of four profile models powered by a single .049 engine flying in formation on the end of a tether. The term profile comes from the fact that the fuselage is made from a flat sheet cut to the shape of the side view, or profile, of the full-size airplane. This is true of the wings and tail surfaces as well, since they are made from a flat sheet and do not have a true airfoil shape, though the wings do have a round leading edge and a triangular trailing edge. Even so, as these profile Blue Angels fly around on the end of the tether with the ½A engine pulling them through the air, you hardly notice that they are profile models except from certain angles.

This is the most complicated project in the book but if you take your time and build carefully, you will be pleased to find that assembly is not as complicated as it first appears. The Bill of Materials shows what you'll need in addition to glue, paint, and an .049 engine.

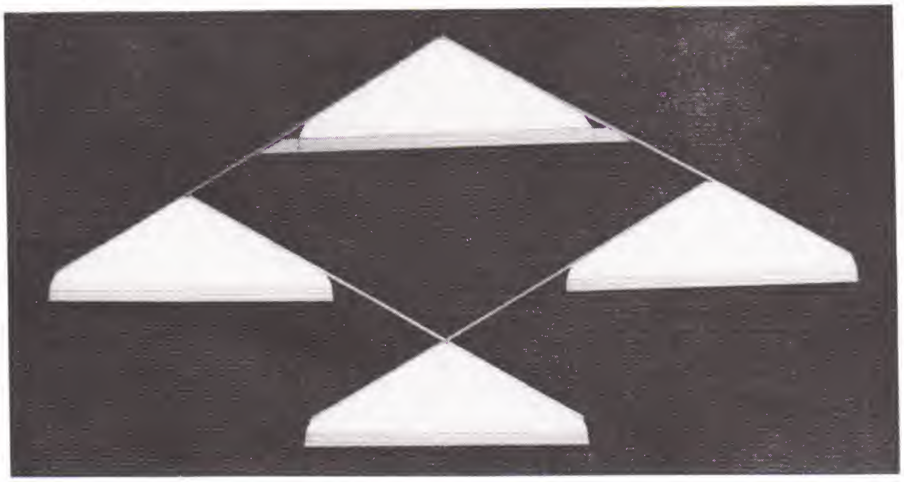
Construction. The lead plane's fuselage should be cut from ¼″ medium-hard balsa since it will take most of the hard knocks. However, for the rest of the fuselages and all of the flying surfaces, you can choose between ¼″ balsa, ¼″ Aerolite Foamboard, or any 3/16″ to ¼″ foam-core board — I used Aerolite and my assembly instructions assume that you'll also use this material.

Prepare cardboard templates by first enlarging the fuselage, wing, and horizontal stabilizer outlines on the plans to full-size (they are printed one-fifth size), then cut out the templates.

Trace the outlines of the templates onto a 16″ x 48″ sheet of ¼″ Aerolite Foamboard. The drawing shows how to lay out the surfaces so you will get four wings, four stabilizers, and three fuselages from one sheet with a little material left over. In the photo the leftover



If you lay out the four stabilizers, three fuselages, and four wings as shown in these photos, you can cut all from a single 16″ x 48″ sheet of ¼″ Foamboard.



The lead plane's trailing edge piece extends beyond the wing tips to the dowels.

end of the 48″ sheet has already been cut off at the trailing edge of the tail surfaces. Another picture shows the parts as they were laid out on the Aerolite. They have been separated slightly for clarity.

Now prepare the fuselage and vertical stabilizer and rudder for the lead plane, using a ¼″ x 3″ x 36″ sheet of medium-hard balsa. First cut out the fuselage, then the vertical stabilizer and rudder. Be certain to hold your X-acto knife or single-edge razor blade perpendicular to the wood so that the parts will join perfectly and will appear to have been cut from a single 6″-wide sheet (6″ sheets are expensive and hard to find). Set these pieces on a flat surface and glue them together.

In each fuselage, cut a slot where the horizontal tail fits into the fin, making certain that the slot is parallel with the wing saddle cutout in the bottom of the fuselage.

So here we are, with all the parts cut out for four profile models of the A-4F. Before we put them together in the famous diamond formation, a couple of points are worth noting.

First, if the rear plane in the formation of full-size Skyhawks were to fly directly behind the lead plane as I've placed it in the model, its nose would be burned off by the leader's exhaust. In the full-size formation, Tail-end Charlie flies well below the leader, clear of his exhaust.

In the model arrangement, we just overlook the point. If someone brings it up, just say "Yeah, I know, but I couldn't figure out an easy way to get the rear plane lower. If you have a better solution, I'll be glad to try it." The answer will probably be something like "No, I don't have. Besides, they look good just the way they are." Of course, if a better solution is forthcoming, use it. However, I think you'll find the odds pretty heavy against such an occurrence. The second point is this: Note the similarity between the diamond shape of the Roamin' Rhombus and the Blue Angels formation. When you think about it, the Blue Angels formation is like a diamond wing with holes in it. That's also one reason why the glide isn't too good.

In order to provide greater aerodynamic stability, the rear wing of the Roamin' Rhombus is twisted so that it is at a small negative angle with respect to the forward wing. You'll see that the wing of the rear plane in the Blue Angels formation is at a small negative angle relative to the lead plane for the same reason.

Let's continue with assembly. Indent the leading edge of the Aerolite wings with a ¼″ dowel as you did with the Roamin' Rhombus. You are now ready to connect the leading edges of the wings to each other with ¼″ dowels. Using white glue, Titebond, Fas-Tac, or epoxy, attach two 24″ dowels to one of the wings so the dowels meet at the apex. Mark each dowel 15¼″ from the apex of the lead plane's wing — that is where each dowel will meet one of the wingman planes.

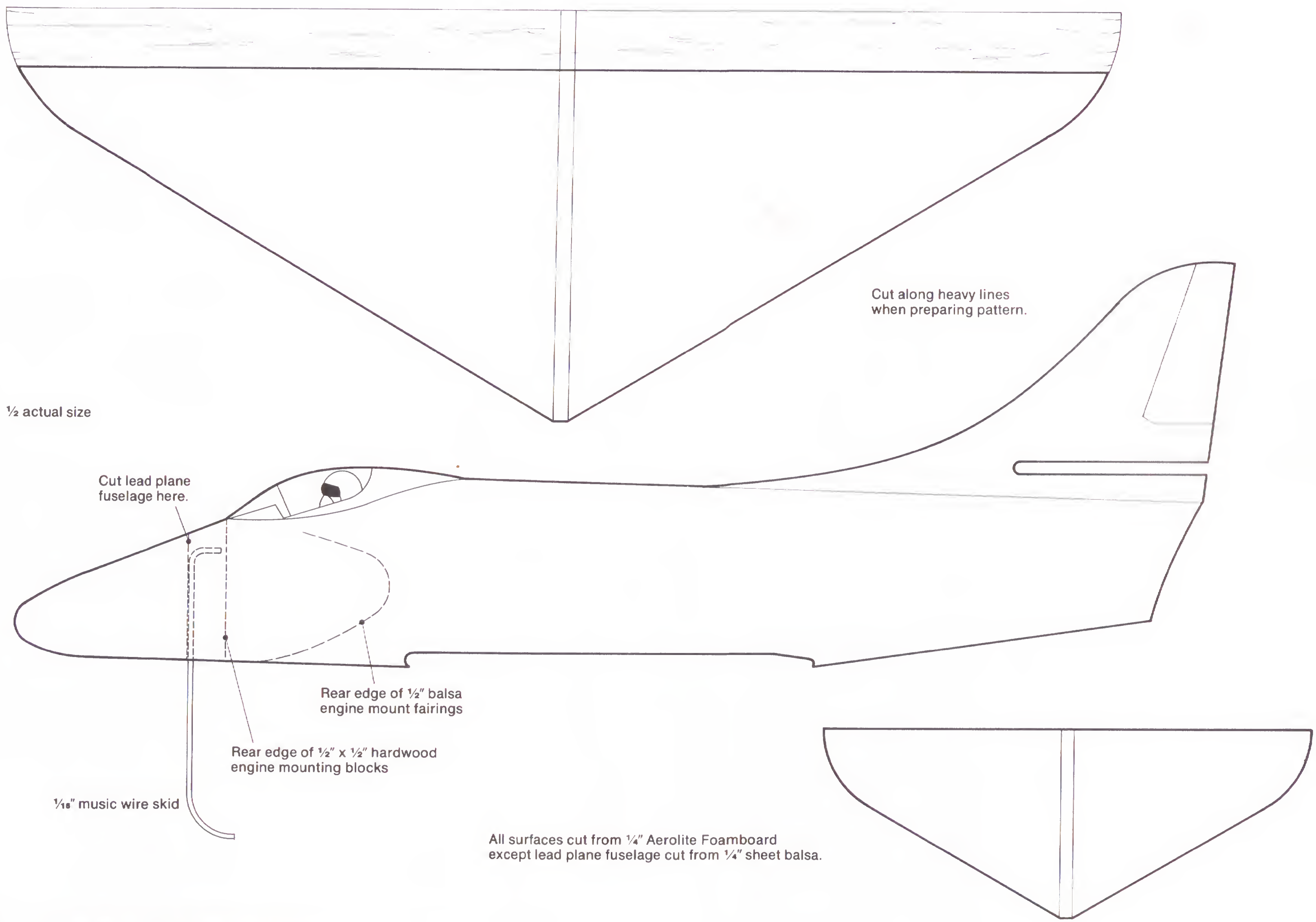
You need a flat surface at least 36″ x 48″ for the next step. Lay all four wings on this surface, positioned exactly as they will be when permanently joined by the dowels. Note that the dowels connecting the rear plane to the wingmen planes cross at the apex of the rear plane's wing. This requires careful notching on your part. Cut one dowel halfway through from its top and the other dowel halfway through from its bottom. Make the cuts at the angle at which the dowels intersect. When that is done, glue the entire wing assembly together.

After the glue dries and you pick up the structure, you'll immediately notice that it seems a bit floppy. Don't worry; the floppiness goes away as you continue with assembly.

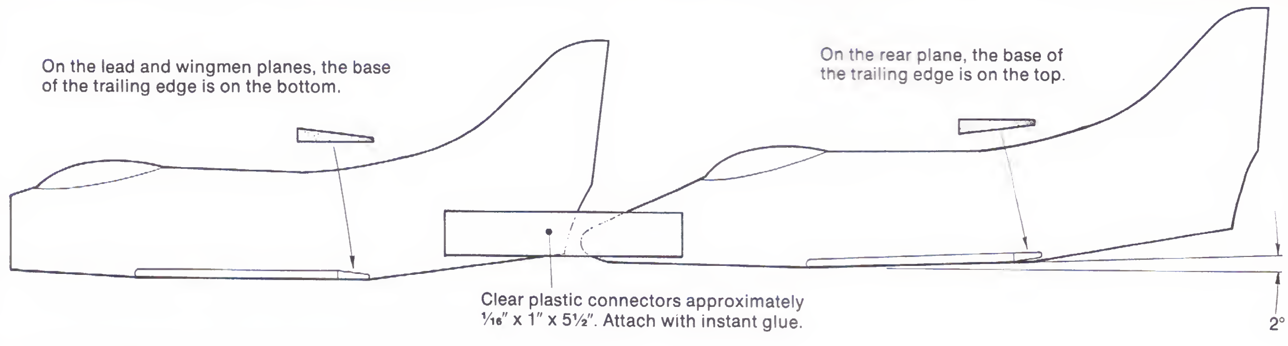
Next attach the trailing edges to the wings. Use ¼″ x ¾″ balsa triangular trailing edge stock. For the lead plane and the wingmen planes, glue the trailing edge stock so that the bottom of the

Bill of Materials

- A 16″ x 48″ sheet of ¼″ Aerolite Foamboard or the equivalent area of ¼″ sheet balsa
- A 3″ x 36″ sheet of ¼″ medium-hard balsa
- Four ¼″-diameter dowels, each 24″ long
- Two pieces of hardwood ½″ x ½″ by about 2″
- Two pieces of soft balsa ½″ x 1½″ x 3″
- Two 36″ pieces of ¼″ x ¾″ balsa trailing edge stock
- Two pieces of clear plastic 1/16″ x 1″ x 5½″
- A 5″ piece of 1/16″ music wire
- Three Goldberg nylon wing skids
- Four ½″ wood screws



WING, FUSELAGE, AND HORIZONTAL STABILIZER PATTERNS



ALIGNING THE LEAD AND REAR PLANES

The horizontal stabilizer on each Skyhawk slips into a slot in the fin and the wing fits into a notch on the bottom of the fuselage, virtually guaranteeing accurate alignment. The planes are ready for painting.

wing is flat across its entire chord. For the rear plane, invert the trailing edge stock so that the top of the trailing edge is in line with the top surface of the wing. This helps to give the angular difference needed for stability in flight.

Also, take a close look at the plans: The trailing edge stock for the lead plane extends beyond the wing tips and is glued to the dowels extending from the leading edges, ensuring sufficient strength to take the bending stresses in this area when you fly the Blue Angels.

Now prepare the engine and landing gear mount for the lead plane. Cut off the nose of the balsa fuselage along the dotted line which is farthest forward on the plans. (There is another dotted line behind this, which shows where the landing gear skid wire fits, and still another dotted line, which is the rear edge of the engine mounting blocks.) The photo shows the nose section cut off and the engine mounting blocks, cut from ½" x ½" hardwood, glued to the sides of the fuselage.

Next, add fairings made from ½" soft balsa to the engine mounting blocks and sand the fairings to a streamlined shape. The streamlining isn't really necessary, but does add a touch of class.

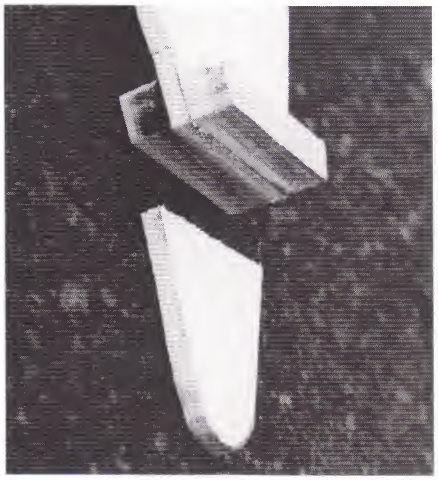
With the engine mount completed, it's time to glue all four fuselages to their wings and to slide the horizontal stabilizers into place. In the picture the tail surfaces of all four planes have been inserted in the slots, lined up parallel with the wings, and glued in place.

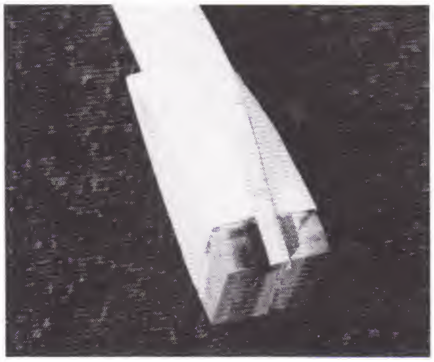
Install the clear plastic connectors between the lead and rear planes. Note the rectangular clear plastic connector, 1" deep and 5½" long. There are two of these, one on each side. The clear plastic is approximately $\frac{1}{16}$" thick. You will find that when the plastic connectors are installed, the whole framework becomes rigid and strong enough to take the stresses imposed in flight.

You establish the correct angular setting of the rear plane to the lead plane when you glue the plastic in place. The plans show that angle to be two degrees. To achieve it, place the assembly on the flat working surface so that all the wings are flat on the surface. Hold the lead plane's wing flat and gently lift the rear plane's tail until the trailing edge of its wing is ⅜" off the surface. Hold the tail in place and glue the connectors to the fuselages — I suggest that you use Hot Stuff Super T, Zap-A-Gap, or some other thick instant glue.

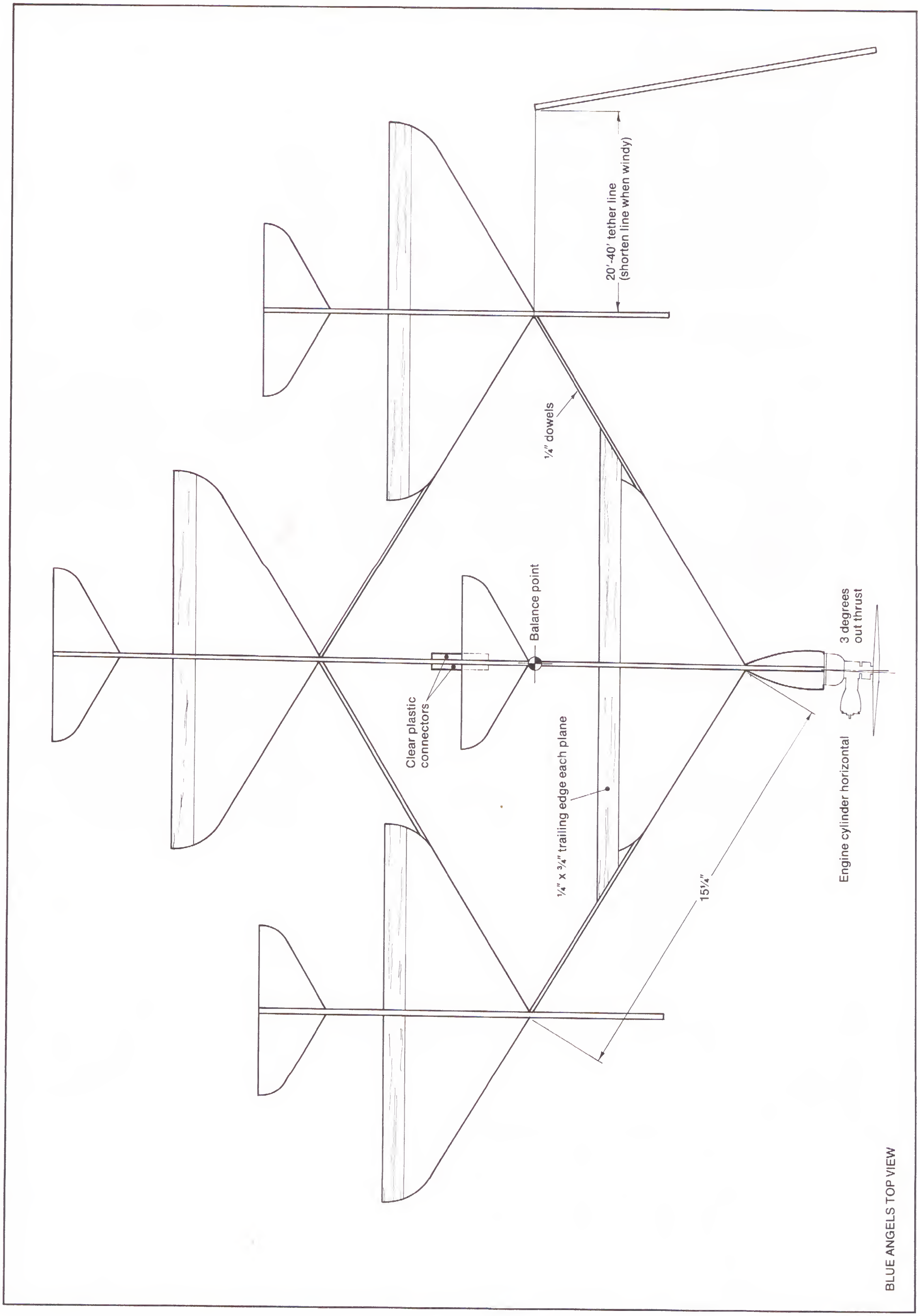
Painting and decorating. The Blue Angels are now ready to be painted. The easiest method by far is to spray the whole assembly (mask the clear connectors) with a dark blue paint such as Pactra Formula U that won't attack foam plastic. Spray the assembly right side up, let it dry, turn it over, and spray the bottom.

Decorating the assembly with gold stripes, numbers, and lettering takes a bit of doing but is worth the trouble. There are two ways. One is to paint the markings by hand. The other is to use Top Flite gold Trim Monokote. Cut out pieces in the shapes shown — including the lettering and the numbers — and stick the Trim Monokote in place. Actually, I employed a combination of the two methods on the prototype. I cut the gold stripe on the fuselage, the numbers, and letters from Trim Monokote and painted the wing tips with

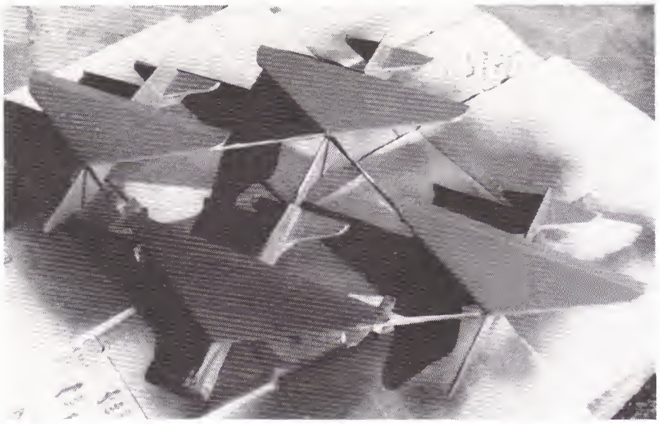


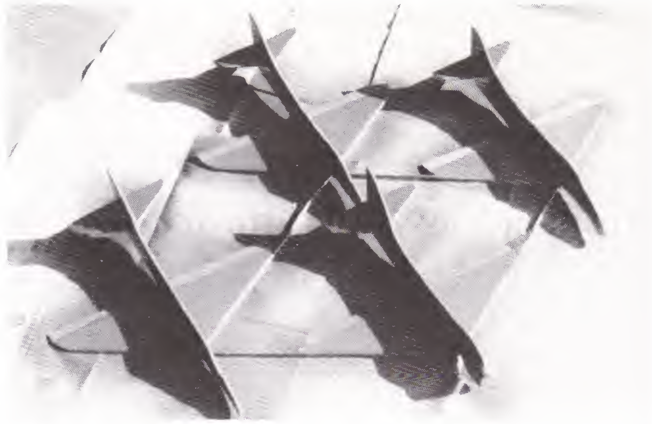


(Left) Remove the forward portion of the nose on the balsa fuselage for the lead plane and glue two hardwood motor mounting blocks in place. (Above left) Add soft balsa fairings behind the hardwood blocks. (Above right) Then carve and sand the hardwood and balsa to a streamlined shape. The engine mounting screws will pass into the hardwood.



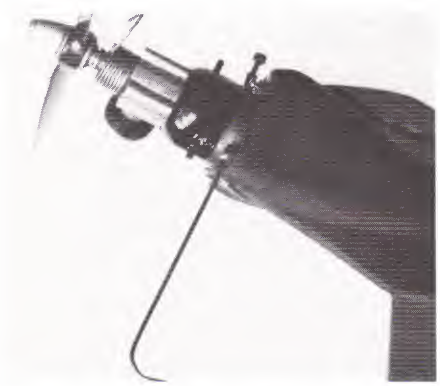
BLUE ANGELS TOP VIEW





The best paint job for the Blue Angels is also the simplest. Just spray the bottoms of the planes with gloss dark blue paint, let this coat dry, then spray the tops the same color. Several layers of newspaper will protect your working surface from overspray.

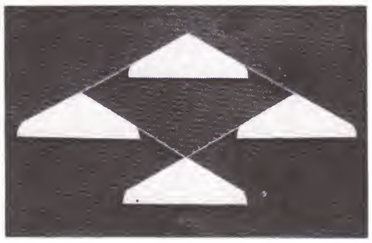
Mount the engine horizontally. Offset the engine about three degrees to the right to provide out thrust that will help maintain tension on the tether in powered flight.



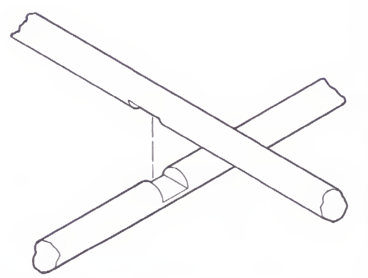
The music wire nose landing gear is sandwiched between the backplate and the motor mount; it's nearly invisible in flight.

gold paint. I first hand painted the words Blue Angels in gold onto eight pieces of dark blue Trim Monokote, then cut out the names and applied the Trim Monokote to both sides of the fuselages.

Use a toothpick as a pen to paint the names. Dip the end in a bottle of gold paint, then write the letters as uniformly as you can. The paint will occasionally run down the toothpick and deposit a blob of gold; discard that piece and try again. It took me fifteen tries to get the eight finally done right.



¼″ dowels inset into leading edges



Notch the dowels at apex of the rear wing like this.

CONNECTING THE WINGS WITH DOWELS

The numbers on the fins are as follows: Number one is the lead plane, two is the right wingman, three the left wingman, and four is the rear plane.

You can paint the canopy area on each plane with any light-colored fuelproof paint and may choose to further detail this area to show portions of the cockpit and a pilot. Finally, hand paint the dowel connectors between the planes a pale blue to match the sky.

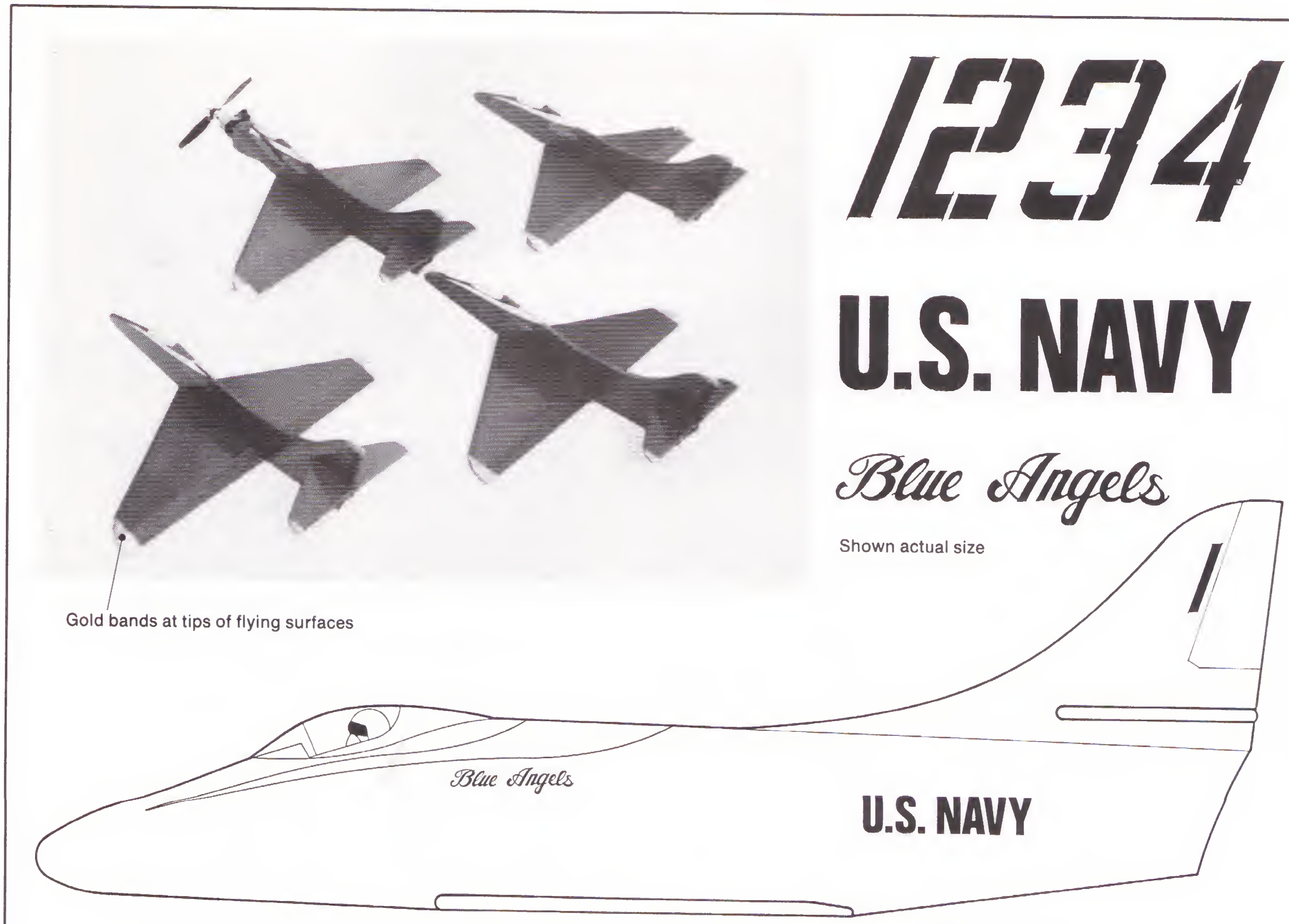
Final assembly. All that's left in the construction sequence is to install the landing skids and the engine. To protect the engine and propeller on landings and takeoffs, insert a piece of $1/16''$ music wire in the nose. The plans show the wire extending far enough so that the propeller will clear the ground when the Blue Angels are sitting on the ground. This wire is attached to the front of the fuselage by cutting a $1/16''$ slot down the center of the front end of the $1/4''$ balsa fuselage. Note that the upper end of the wire is bent at right angles for about $1/2''$ and the end is pressed into the balsa until the wire fits snugly in the slot. The engine's backplate will hold the wire in place.

I first painted the gold Blue Angels lettering onto pieces of dark blue Trim Monokote with the tip of a toothpick and then removed the backing sheet and applied the self-adhesive Monokote to the models.

Goldberg nylon wing tip skids protect the undersurfaces from scratches on takeoffs and landings.

Mount Goldberg nylon wing skids on the wing tips of the wingmen planes with another skid under the center of the trailing edge of Tail-end Charlie's wing.

Installing the engine consists of securing the backplate of the tank to the engine blocks with $1/2''$ wood screws. However, before you do so, observe that the engine should be canted to the right as seen from above. When you fly the formation counterclockwise, the engine will be pointed slightly out from the direction of flight. This helps maintain tension on the tether for positive



BLUE ANGELS COLOR SCHEME

COLORS: Overall dark gloss blue except for the gold lettering, tail numeral, fuselage stripe, and bands at tips of flying surfaces. The canopy area is any light-colored paint. The dowel connectors between planes are pale blue.

response when you pull the nose up or down with the line.

You can achieve this out thrust in two ways. One is to sand the front ends of the engine blocks at an angle — about three degrees. The other is to put washers between the backplate and the mount on the inboard side. The washer method also allows you to reverse the direction of flight, should you ever want to do so, by inserting the washers on the other side. The drawback is that the backplate does not fit snugly against the front of the landing gear wire and you'll have to epoxy the wire in place. I recommend that you sand the blocks to the correct angle. Alternatively, if you have the eye for it, you could cut the front edges of the engine mounting blocks at the desired angle before gluing them on. If you do, be sure they are lined up.

For appearances' sake, mount the engine so that the cylinder is horizontal. If you have a Dragonfly .049, this has already been done for you. If you have an older model, simply unscrew the tank mounting bolts, pull the tank back, rotate the cylinder 90 degrees, and remount the engine to the tank.

Test flights. Before flying the Blue Angels, make sure that the formation is properly balanced. When suspended from the balance point shown on the plans, the formation should hang level or slightly nose down. If the formation hangs nose high, add the lead weight near the engine; if it hangs more than a few degrees nose down, add lead to the tail of the rear plane.

Tie the tether to the formation at the point shown on the plans — the pulling force on the line will be slightly ahead of the balance point — just where you want it for good control.

What do you use for the tether? Any strong twine or fishing line will do. Fifty-pound test nylon fishing line works well and is more than strong enough. When flying the Blue Angels, you'll raise your arm to bring up the formation's nose and lower it to move the nose down.

You can obtain greater control response by using an extension rod. Make an extension from a 36″ piece of broomstick or use an old fishing rod cut to 36″. If you have an old reel as well, you can wind the tether on the reel. If you don't use a reel, tie the end of the tether firmly to the outer end of the stick. Because it ensures greater control response, the extension's a valuable safety measure for the first few flights; you may dispense with it later if you prefer.

The formation can actually be flown unpowered by whipping. To do so, just pull the group forward faster and faster, leading it slightly with the tether until it becomes airborne. However, this can only be done with a relatively short tether — about 15 feet at most — and you'll be turning around rapidly. Whipping on a short line will make you dizzy faster than will flying the formation powered on a 20- to 25-foot line. However, short flights in which you whip the formation will give you an idea of whether it is properly balanced.

Also, whip the formation after the engine stops during powered flights to help the Blue Angels glide better and land more smoothly.

Your flying site should always be an open area large enough that you can step away from your starting point as necessary to maintain tension on the tether. You'll have to move downwind to keep the Blue Angels from drifting in toward you and causing you to lose control as the line slackens. For your first test flights, pick a calm day.

Useful addresses

Ace R/C, Inc.
P. O. Box 511
Higginsville, MO 64037

Aerolite Products, Inc.
1325 Millersport Highway
Buffalo, NY 14221

Cox Hobbies, Inc.
1525 East Warner Avenue
Santa Ana, CA 92705

Davis Diesel Development Co.
Box 141
Milford, CT 06460

Carl Goldberg Models, Inc.
4734 West Chicago Avenue
Chicago, IL 60651

Grish Brothers, Inc.
P. O. Box 248
Saint John, IN 46373

Hunt/X-acto, Inc.
1405 Locust Street
Philadelphia, PA 19102

Model Builder
621 West Nineteenth Street
Box 10335
Costa Mesa, CA 92627-0132

Pactra Industries, Inc.
7060 Hollywood Boulevard
Los Angeles, CA 90028

R/C Modeler
144 West Sierra Madre Boulevard
Sierra Madre, CA 91024

Sig Manufacturing Co., Inc.
Route 1, Box 1
Montezuma, IA 50171

Sterling Models, Inc.
3620 G Street
Philadelphia, PA 19134

Top Flite Models, Inc.
2635 South Wabash Avenue
Chicago, IL 60616

Acknowledgments

No one person is likely to come up with all the ideas needed to make a book like this and it is only fitting that those who suggested some of the projects should be thanked.

Mike Mas, the well-known world champion model helicopter pilot, suggested I include the Fantastic Ragtime Flying Machine. Mike said he used to fly one when his helicopter got balky.

The Rotoriser design used in the book is a variation on a smaller version. Brian Bush, a modeler in Florida, built the prototype which we used.

My friend Bert Williamsen gave me the idea for the Spindizzies. He had experimented with them in various forms and found them amusing. So did I.

Thanks are also due to Dick Kidd of *R/C Modeler* magazine and Bill Northrop of *Model Builder* magazine for offering to let us use their plans services.

For his expertise in checking the text for spelling, consistency in terminology, and other aspects of properly presenting the material, I am indebted to Burr Angle, who did the job assigned to him and never complained — at least to me.

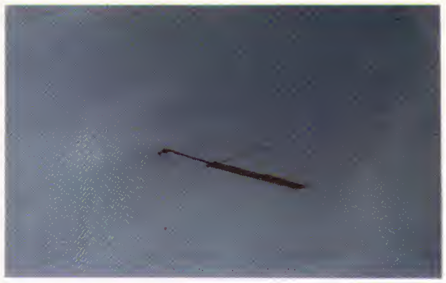
Finally, thanks are especially due to my wife, Kathleen, who put up with my idiosyncrasies, ill-tempered remarks when something didn't work, and grumbling about the weather when I wanted to test one of the machines and it was raining. She also posed her hands for me when I wanted to demonstrate some building technique.

Without the help of all these people, there is no way this book could have been written.

At least, not by me. My thanks to them all.

Ken Willard

Novices and experts alike will enjoy building and operating these projects, each of which is powered by a small, inexpensive, glow-ignition model airplane engine turning a two-bladed propeller.



½A engines, modeling supplies, and safety
1. The Fantastic Ragtime Flying Machine
2. The Flingthing
3. The Sunday Flier
4. The Rotoriser
5. Spindizzies
6. The Puddle Jumper
7. The Roamin' Rhombus
8. The Blue Angels

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